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A LIFE HISTORY SKETCH OF THE ALLEGHENY WOODRAT

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In 1922, while making a regional survey of the mammalian life of Berks County, Pennsylvania, I became impressed with the dearth of available definite information on the life history of the Allegheny woodrat, *Neotoma magister* Baird (for use of the name *magister* see Jour. Mamm., this number, pp. 316–318). I decided, therefore, to attempt to fill in this lack, since the animal in question is locally common along the Blue Ridge, which forms the northwestern boundary of this county. During the past ten years I have collected a large series of these rodents in their native habitat among the rock ledges, clefts and slides of the ridge, and have had many interesting experiences with them, culminating in several successful ventures at raising them in captivity.

The first of these attempts has been recounted at some length (Poole, 1936). Since that time I have kept four pairs approximately a year each, and have had four litters of young born in captivity.

In each case the animals were kept in large double glass-fronted cages, each of which contained a suitable nesting box that could be opened from the outside. Each animal had its own cage; and doors in the partitions between the pairs of cages made it possible to separate the animals when this was advisable.

The cages were placed in a large areaway where they could be observed from a window, but were subject to the normal outdoor temperatures. In this way the behavior of the animals was probably little affected by confinement. On several occasions when individuals escaped they voluntarily returned to their nests.

They were frequently fed by hand to keep them tame, but they were not handled more than was absolutely necessary. They were quickly tamed, as a rule, and soon learned to eat out of the hand. The females were more tractable than the males; also bolder and more curious. Practically all of

the females quickly became pets and showed little anxiety, even when I opened the nest boxes to look at the young; but several of the males remained wild and shy even after spending several months in captivity.

To supplement my observations, Dr. W. J. Hamilton, Jr. of Cornell University, Messrs. Newton Hartman, of Philadelphia, and Daniel Smiley, of Lake Mohonk, New York, have generously sent me their manuscript notes on this mammal as they have observed it in the field and in captivity.

DISTRIBUTION

The general range of *Neotoma magister* is in the Appalachian Mountain system, from western Connecticut (Schaghticoke Mountain) to northern Alabama, (Gunter's Mountain) and west into Kentucky (Mammoth Cave), Indiana (Harrison County) and Tennessee (Lawrenceburg). In this area it is found sporadically, through the Alleghenian and Carolinian zones, ranging from near sea level (Washington, D. C.), to 4000 feet at Rich Mountain, Tazewell, Virginia (A. H. Howell, July 31, 1908).

The range of this species has probably shrunken considerably since the settlement of this country. While a few isolated colonies exist away from the main range of the animal, many places that seem well suited to its needs are now deserted.

The Tuscarora sandstone, which forms the backbone of the Appalachian Mountain ranges, seems to provide the chief habitat of this animal at the present time. This exceedingly hard rock weathers into large boulders. It is traversed, wherever exposed, by many deep crevices and galleries that often extend to a great depth. In many places throughout these mountains great slides of broken boulders form bare patches on the slopes. Wherever these conditions are sufficiently extensive, one is likely to find signs of *Neotoma*.

This woodrat is found also on cliffs in other rock formations where conditions are similar, such as the Palisades of the Hudson, the limestone cliff region of southern Ohio, Indiana, and Kentucky, and in the limestone caves of Kentucky, Tennessee, and Virginia.

We have definite records of this species, supported by specimens, or references in the literature, from the following localities:

Alabama:	Madison Co.	Monte Sano, near Huntsville (Howell, 1909)
	" "	Gunter's Mountain, near Fort Deposit (Howell, 1921)
	Jackson Co.	Woodville (Howell, 1921)
	Lauderdale Co.	Northern shore of Muscle Shoals (Howell, 1921)
Connecticut:	Litchfield Co.	Schaghticoke Mountain, (Liberty Hill) (Goodwin, 1935)
Indiana:	Harrison Co.	Tobacco Landing (Hickie and Harrison, 1930)
Kentucky:	Breathitt Co.	Fallen Rock Branch (Hamilton, 1930)
	" "	Lost Creek (Howell, 1910)
	Hancock Co.	Hawesville (Howell, 1910)
	Edmonson Co.	Mammoth Cave (Howell, 1910)
	Boyd Co.	Catlettsburg (U. S. Biol. Survey Coll.)
	Carter Co.	Cascade Cave (nest with young)
Maryland:	Montgomery Co.	Plummer's Island (Bailey, 1923)
	" "	Woodside (Wetmore, 1923, p. 188)
New Jersey:	Passaic Co.	Greenwood Lake (Rhoads, 1903)

New York:	Orange Co.	Torne Mountain, near Suffern (Luther Hook, ms. notes)
	" "	West Point (U. S. Nat. Mus. Coll.)
	Ulster Co.	Lake Mohonk (D. Smiley, ms. and photographs)
Ohio:	Adams Co.	(Hine, 1929)
	Hocking Co.	Goodhope Township, near Rockbridge (U. S. Biol. Survey Coll.)
	Fairfield Co.	Sugar Grove (Hine, 1929)
Pennsylvania:	Adams Co.	South Mountain, near Graffensburg (Rhoads, 1903)
	Bedford Co.	Cook's Mills (Rhoads, 1903)
	Berks Co.	The Pinnacle, Shartlesville, Hawk Mountain (Reading Public Mus. Coll.)
	" "	Reading (2 miles south), remains in 4 Indian sites (Reading Public Mus. Coll.)
	" "	Strausstown (Reading Public Mus. Coll.)
	Bucks Co.	Durham Cave (remains) (Philadelphia Acad. Nat. Sci.)
	Cambria Co.	Near Walsall (Philadelphia Acad. Nat. Sci.)
	Clinton Co.	Drury's Run, Renovo, Round Island (U. S. Biol. Survey Coll.; Philadelphia Acad. Nat. Sci.)
	Cumberland Co.	Lewis's Cave Rocks, South Mountain (type locality of *pennsylvanica*) (Stone, 1893)
	" "	Near Carlisle (floor of cave, type locality of *magister*)
	Lancaster Co.	Cold Cave, near York Furnace (Roddy, Franklin & Marshall College Mus. Coll.)
	" "	Near Cornwall Iron Mines (H. Lane, Franklin & Marshall College Mus. Coll.)
	" "	Hess Cave, near Reffton (recent remains) (Reading Public Mus. Coll.)
	Lehigh Co.	Bake Oven Knob (Reading Public Mus. Coll.; Philadelphia Acad. Nat. Sci.)
	Monroe Co.	Near Saylorsburg (fresh droppings and other evidence) (E. Poole, 1930)
	" "	Hartman Cave (Philadelphia Acad. Nat. Sci.)
	Schuylkill Co.	Pine Grove (specimen examined but not preserved) (E. Poole, 1930)
	Somerset Co.	New Lexington, Summit Mills (Philadelphia Acad. Nat. Sci.)
	Westmoreland Co.	Laurel Hill, near Laughlintown (Rhoads, 1903)
Tennessee:	Lawrence Co.	Lawrenceburg (Howell, 1909)
	Hamilton Co.	Walden Ridge, near Soddy (Howell, 1909)
	Montgomery Co.	Clarksville (U. S. Biol. Survey Coll.)
	Humphreys Co.	Duck River, near Waverly (U. S. Biol. Survey Coll.)
Virginia:	Buckingham Co.	(U. S. Nat. Mus. Coll.)
	Fairfax Co.	Difficult Run, near mouth (Goldman, 1910, p. 86)
	" "	Great Falls (Bailey, 1923)

	Fairfax Co.	Potomac River, 10 miles above Washington, D. C., (U. S. Biol. Survey Coll.)
	" "	Franklin (Goldman, 1910, p. 86)
	Loudoun Co.	Hillsboro (Goldman, 1910, p. 86)
	" "	Potomac River, opposite Hog Island (U. S. Biol. Survey Coll.)
	Wythe Co.	(Rhoads, 1894, p. 220)
	Bedford Co.	Peaks of Otter (Goldman, 1910, p. 86)
	Tazewell Co.	Tazewell Peak (Howell, 1909)
	Rappahannock Co.	Washington (Howell, 1909)
	Warren Co.	Fort Valley, 750 ft. alt., Massanutten Mountain (Miller, 1898)
West Virginia:	Pendleton Co.	Circleville (Newcombe, 1930)
	" "	Hermit Island, Hanging Rock (W. J. Hamilton, 1931, ms. notes)
	" "	Franklin, near Madison (U. S. Biol. Survey Coll.)
	Pocahontas Co.	Cranberry Glades (U. S. Nat. Mus. Coll.)
	Barbour Co.	Philippi (U. S. Biol. Survey Coll.)
	Preston Co.	Cornwall Cave, Cheat River (Patterson, 1933)
	Greenbrier Co.	White Sulphur Springs (U. S. Biol. Survey Coll.)

NESTS

The usual type of nest constructed by this woodrat is shaped much like that of birds of the size of a blue jay or a grackle. It is bulky, and well made of the shredded bast fibers of chestnut, hemlock, red cedar, basswood, wild grape, or some similar material. Oakum or tow is used when it is available.

Maurice Broun and I found a typical nest of this sort in an old trough in the basement of a stone house on the Hawk Mountain Sanctuary in Berks County, Pennsylvania (pl. 2). This nest had an outside diameter of 460 mm. and an outside depth on one side of 160 mm. The nest cavity was 120 mm. in diameter, 80 mm. deep on one side and 130 mm. on the other, the higher side being the one exposed to the light and draughts. It was constructed of unravelled rope, rootlets, grasses, and grapevine bark, and contained many chicken feathers that had been carried in from a nearby chicken house. The coarser material was on the outside, the lining of the nest being fine and soft.

Several other nests that I have found in sheltered places conformed to this type, with slight variations, and most of those that have been described were closely similar, merely varying in size. Rhoads (1903, p. 89) quotes E. D. Cope as saying that in a certain cave in Wythe County, Virginia, he found nests large enough to fill a bushel basket. In a cave in Pendleton County, West Virginia, Patterson (1933 p. 39) found that the nests varied in outside diameter from 35 to 60 cm.

Hamilton (ms.), in describing *Neotoma* work in the same cave, says: "Among the ledges, inside the cave, and in total darkness are abundant nests, composed on the outside principally of red cedar twigs 4 to 10 inches in length. The inside of the nest is composed entirely of finely shredded bark of red cedar; . . . I counted 8 of these nests in an area of 30 feet and 3 on one rock shelf, approximately 2 feet from one another. Many green cuttings are about these nests, which are from thirty to a hundred feet within the cave."

C. L. Newcombe (1930, p. 207) describes a smaller nest of the open type from West Virginia, and is inclined to think that the "rats of this generation used the nests of their parents." He also wrote that, according to his observations, the nest proper is reached

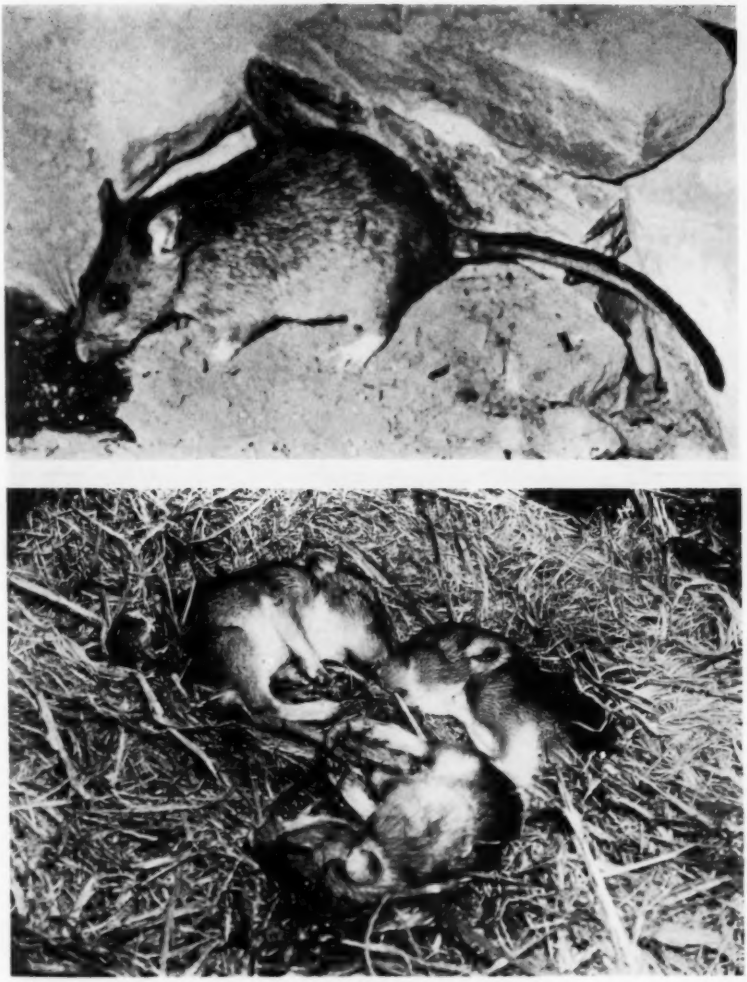


PLATE 1

Upper.—Adult *Neotoma magister* at sardine oil bait, Bake Oven Knob, Lehigh Co., Pa., July, 1937.

Lower.—Three young of *Neotoma magister* in nest, Cascade Cave, Carter Co., Ky., after mother was killed two nights previously. June 24, 1937 (photos by Chas. E. Mohr)

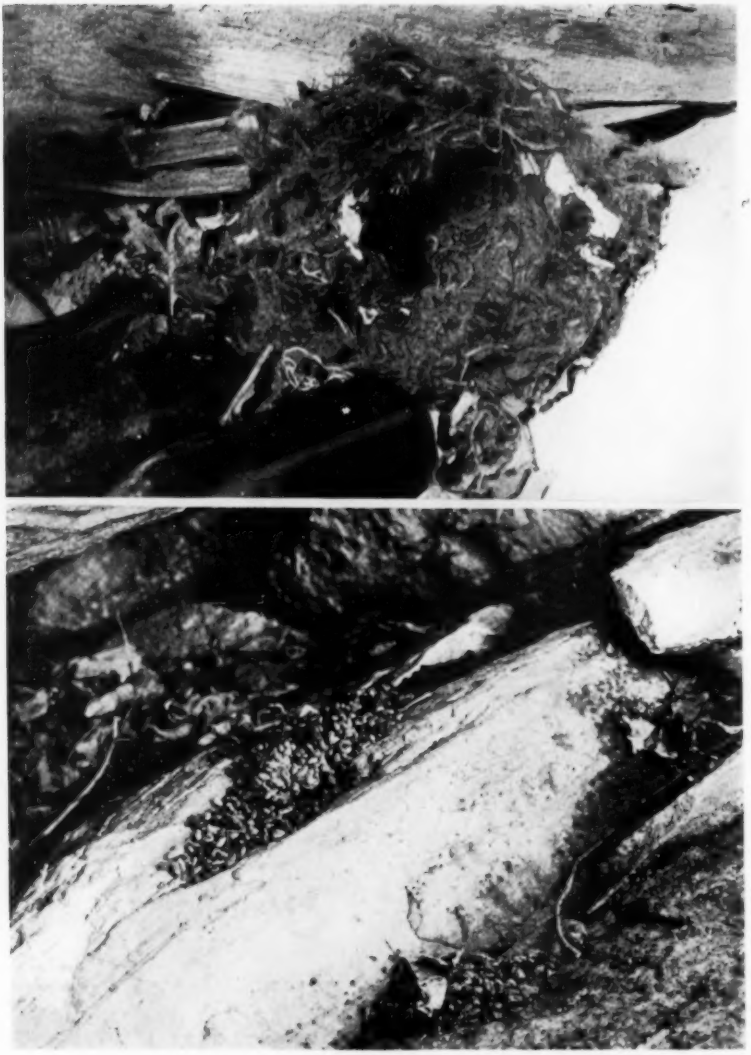


PLATE 2

Upper.—Nest of *Neotoma magister* in trough with bottles in basement of Schaumbok house, Hawk Mountain, Berks Co., Pa. (photo by Maurice Broun)

Lower.—Scat pile of *Neotoma magister*, Bake Oven Knob, Lehigh Co., Pa. (photo by Chas. Mohr and Saml. Wishnieski)

by two or more entrances, thus facilitating escape of the rats when attacked by enemies. However, according to Rhoads, (1903, p. 91) "a nest of this species found in a small cavern near the crest of the mountain at the sources of Cook's Run, Clinton County, was set among loose boulders in the cavern and was composed externally of oak leaves, small branches, sticks and moss. Within this mass, which would nearly fill a half bushel measure, the nest proper was composed of grass and long strippings of inner bark of chestnut and hemlock in a spherical form *with a single entrance*, so far as could be discovered, the nest being much damaged in extricating it." Francis Trembley tells me that he has seen covered nests of this type, "looking like muskrat houses" in a rock slide in Monroe County, near Wind Gap. These nests could not be found in August, 1939, when I visited that locality.

All the nests that I have observed were of the open type and were in locations that could be approached from several directions. It is probable that the builders instinctively avoid a cul-de-sac.

The nest may be located in the inaccessible deep crevices of large rocks, in similar crevices or on ledges in caves, or in corners that are wide enough to permit of escape. In winter the rats often move into houses and outbuildings. I have seen three such nests in one old house.

One young rat that I captured at Bake Oven Knob was placed in a makeshift cage with a quantity of tow, but without the customary observation nesting box. This individual built herself a completely covered nest with only one entrance at the side. Later when given a box (about 7 by 10 by 14 inches in size) with one entrance at the side, she built the customary open or bird-like type of nest. This would seem to indicate that this animal is intelligent enough to make the best of conditions. Other adult individuals have built in the open cage by preference, using the open type of nest, in summer, at least. Since all of my woodrats were kept in the open throughout the winter in order to give them, as nearly as possible their normal living conditions, I found that they would add to, or remove, nesting material as the occasion required. Sometimes they would fill their snug wooden box with nesting material; and, at the approach of spring they would drag much of it out of the box again.

Occasionally one would decide to camp out in the open cage, and when provided with nesting material, such as excelsior and tow, would proceed to build itself a nest. The process was precisely like that of a bird building its nest, the animal turning around and around, and shredding and fluffing the fibers with its teeth, making quick, skillful motions with its head or forefeet until the nest was completely shaped and softly lined.

Passages to the nests are frequently barricaded with a miscellaneous assortment of sticks, stones, leaves and other objects, doubtless designed to baffle the larger enemies. Frequently, either adjacent to, or at some distance from the nest, a heap of objects equally miscellaneous and of considerable bulk is stored.

Much of this material would seem to be of little actual use, but scattered through it are always some potential food supplies that seem to be in the process of drying, possibly for winter consumption. In the West Virginia cave visited by Hamilton and Patterson, this material consisted of twigs that had been folded in pieces measuring generally 10 cm. in length. Occasionally a well-defined pile of fern fronds, green leaves, mushrooms and other vegetable matter is found, evidently undergoing this curing process, yet in the midst of such a pile may be found some useless object such as a fox scat, evidently deposited by the rat.

While it is difficult to determine the purpose of these heaps of miscellaneous materials, experience with captive animals has shown that those from different localities, and even different individuals, may follow different plans of storing food and disposing of waste material. Many individuals stored all surplus food in the nest box or in the immediate neighborhood of the nest, and each morning removed shells and rejected materials

to a distant part of the cage, or to the roof of the nest box. A few would habitually deposit all emptied nut shells and other rejected material in the water pan.

I believe that some variation of this plan is usually followed in the wild state, and that the more desirable storage food is kept in or near the nest, while the large heaps of refuse found at a distance from the nest may be reserve supplies of less desirable food material, or simply objects that have been carried there in fulfillment of the animal's evident desire to store objects in heaps.

However, as I have previously mentioned, the habits of woodrats may vary much under different conditions, and, as W. J. Hamilton has stated, speaking of West Virginia (ms. notes), "In areas where the rats occur and no caves are present, they build large masses of sticks and trash." In the extensive boulder tumbles of the Blue Mountains, piles of this sort are rarely seen, as the animals' activities are concealed by the deep fissures and crevices in which the woodrats live. In these places barricades of sticks and the scat piles described elsewhere are about the only conspicuous evidence of the presence of these animals.

A rather formidable list may be compiled of plants and objects found near the nests or in the trash piles of this rat. This list probably includes much of the storage food of the animal, as observations in captivity have verified.

MATERIALS FOUND IN AND ABOUT NESTS

(Probably partly food)

mushrooms	*Russula* sp.
	Boletus sp.
	Boletus pallidus
coral fungus	*Clavaria* sp.
	Inocybe sp.
lichen	*Parmelia* sp.
rock tripe	*Umbilicaria pustulata*
moss	*Dicranum* sp.
bracken	*Pteridium latiusculum*
marginal shield fern	*Dryopteris marginalis*
common wood fern	*Dryopteris spinulosa intermedia*
polypody	*Polypodium virginianum*
christmas fern	*Polystichum acrostichoides*
hemlock	*Tsuga canadensis* (twigs)
red cedar	*Juniperus virginiana* (bark)
black walnut	*Juglans nigra*
pignut hickory	*Carya glabra*
mockernut	*Carya alba* (nuts)
black birch	*Betula lenta*
chestnut	*Castanea dentata* (bast fibers and burs)
chinquapin oak	*Quercus muhlenbergii* (leaves, bark, and blossoms)
black oak	*Quercus velutina*
scarlet oak	*Quercus coccinea* (twigs)
red oak	*Quercus borealis* (acorns and leaves)
pokeweed	*Phytolacca americana*
sassafras	*Sassafras officinale* (leaves and twigs)
apple	*Malus pumila* (mainly cores)
juneberry	*Amelanchier canadensis*
pin cherry	*Prunus pennsylvanica* (mostly leaves)
wild black cherry	*Prunus serotina*

black locust	*Robinia pseudo-acacia*
redbud	*Cercis canadensis*
three-seeded mercury	*Acalypha* sp.
spurge	*Euphorbia commutata*
staghorn sumach	*Rhus typhina*
evening primrose	*Oenothera biennis*
summer grape	*Vitis aestivalis*
bristly sarsaparilla	*Aralia hispida* (twigs and berries)
rhododendron	*Rhododendron maximum* (twigs)
white ash	*Fraxinus americana*
phlox	*Phlox brittonii*
hound's tongue	*Cynoglossum officinale*
elderberry	*Sambucus canadensis* (twigs and leaves)
white snakeroot	*Eupatorium urticaefolium*
goldenrod	*Solidago caesia* (fragments)
aster	*Aster* sp. (leaves and fruits)
ragweed	*Ambrosia artemisiifolia*

Nails, coins, bits of tin, china, rags, scraps of leather, bones, a woodchuck skull, watch spectacles, crow, turkey, and chicken feathers, rubber from an old tire, paper, snail shells, shotgun shells, shells of duck eggs, rubber bands, and fox and horse dung are among the miscellaneous items that have also been reported from the nests and middens of this woodrat.

FOOD IN THE WILD STATE

While many kinds of plants are undoubtedly eaten by this mammal, as will be inferred from the list of nuts, fruits, green fungi, lichens, shoots and dried leaves found in and about its nests and "middens," few actual examinations of stomachs have been made, and little direct evidence of the actual food habits seems to be available. The present list of food identified in the viscera of freshly taken specimens is compiled from my list and the notes of others.

puff balls	Sp. (?)
hemlock	*Tsuga canadensis* (green twigs and seeds)
black birch	*Betula lenta* (twigs and seed pods)
chestnut	*Castanea dentata* (nuts)
scrub oak	*Quercus ilicifolia* (acorns)
flowering dogwood	*Cornus florida* (fruits)
apple	*Malus pumila* (fruits and seeds)
wild black cherry	*Prunus serotina* (fruits and pits)
mountain ash	*Sorbus americana* (fruits and seeds)
rhododendron	*Rhododendron maximum* (leaves, in winter)

According to B. H. Warren, (Diseases and enemies of poultry, pp. 5–15) woodsmen in the mountainous parts of Pennsylvania accuse this rat of catching young chickens, wild birds and their eggs, and W. J. Hamilton has heard the same complaint from natives of West Virginia. However, since most country people fail to distinguish clearly between this species and the house rat (*Rattus norvegicus*), I do not place much credence in these statements.

Of the many bones, both ancient and recent, that have been found in caves and rock shelters used by the Indians, throughout this part of Pennsylvania, the great majority have been more or less gnawed by woodrats. This gnawing of bones probably serves

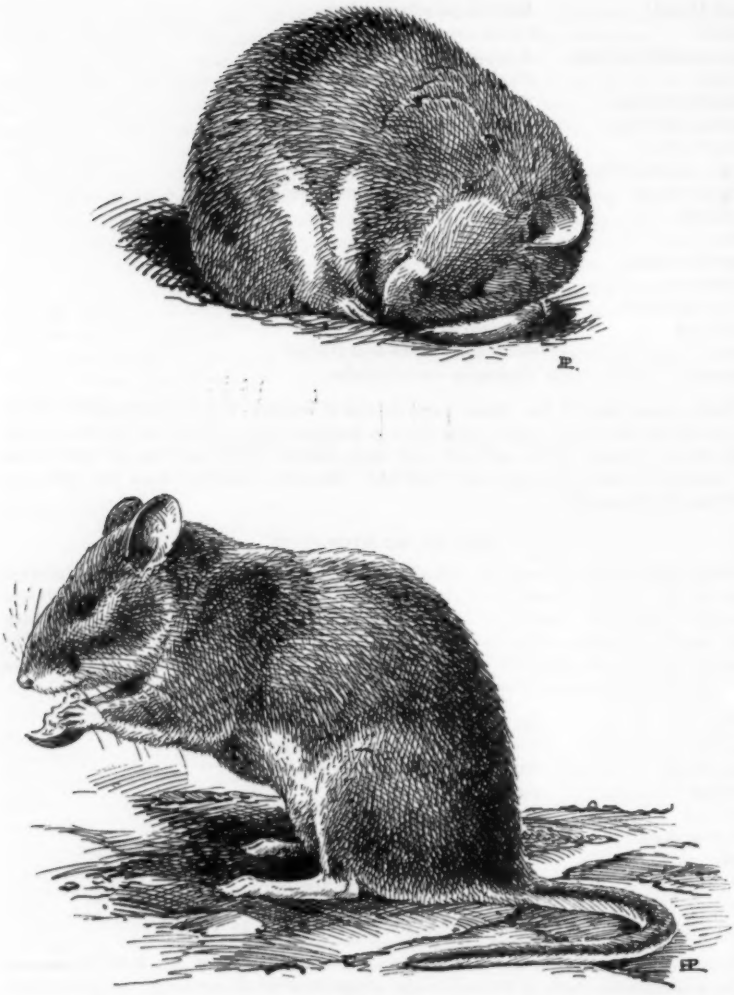


PLATE 3

Upper.—Characteristic sleeping posture of *Neotoma magister* (sketch from life)
Lower.—Feeding posture of *Neotoma magister* (sketch from life)

a double purpose, by sharpening the teeth and providing a source of animal food. All of the animals that I have kept in captivity were fond of chewing on bones. If none were provided they would chew at random on the wooden parts of their cages.

Individuals kept long in captivity do not keep the cutting edges of their incisors as sharp as do those living in the wild.

FOODS EATEN IN CAPTIVITY

In contrast to the rather limited list of foods known to be eaten by *Neotoma magister* in the wild state, we have a much more comprehensive list of foods that are eaten in captivity. These I have arranged in three groups, in the order of their acceptability.The accompanying list is compiled from my own observations, together with lists contributed by Smiley, Patterson, and Newcombe.

First choice:

acorns (various kinds), almonds, apples, seeds and green twigs, bananas, Brazil nuts, cherries, chestnuts, cocoanut candy, currants (dried), lettuce, peaches (dried or fresh), sardines (canned in oil), sweet potatoes, walnuts (English and black, cracked).

Second choice:

cabbage, carrots, celery, cheese, dates and pits, elderberries, grapes, peanuts, pears, raisins, spinach, tomatoes.

Among other foods that were eaten freely, which suggest the probable range of taste in the wild state, might be mentioned, birds (a dead ruby-crowned kinglet was partly devoured by one of Smiley's animals), blackberries, black birch (fresh twigs), bread, bones, butter, corn (fresh and dried), flies (dead), hemlock (green twigs), maples (red and sugar, fresh twigs), meat (raw or cooked, eaten in small quantities), melon seeds, milk, oatmeal, onions, oranges, pecan nuts (cracked), pinyon nuts, white potatoes, prunes and pits, seeds (of melon, squash, sunflower, and trumpet vine), suet, tupelo berries, wheat, and wild rice stalks.

In many cases it has been difficult to state food preferences, as individuals were found to differ in their tastes, and foods that were eaten avidly at first became less desirable after they had lost their novelty.

I found by accident that wild individuals were especially attracted to oil in which sardines were packed. They would forsake any other bait for some of this oil that had been spilled on a rock (pl. 1). Both Daniel Smiley and I found that females in captivity occasionally killed and partially devoured their young; although meat as a rule was eaten very sparingly. This would seem to indicate that animal food is not of major importance, and is only eaten in limited quantities, even when easily obtainable.

Newcombe found that they would not eat bacon, liver, or white potatoes, and lemons only when hungry. My captives would not eat the common field mushroom, *Agaricus campestris*, but would occasionally eat white potatoes. Patterson (1933) wrote that his animals liked white potatoes but would invariably remove onions from the nest whenever they were offered.

Apparently this rat is incapable of gnawing through the shells of English walnuts, black walnuts, and pecans, although it eats the nuts readily when the shells are cracked.

DRINKING AND USES OF WATER

All who have had experience with this animal in captivity agree that it drinks water, "lapping like a dog." Newcombe (1930, p. 210) estimated the average amount of water consumed every 48 hours at 100 c.c., while Patterson's (1933, p. 39) animals drink 200 to 250 c.c. in the same time.

D. Smiley (ms.) mentioned that one of his pets drank continuously for two and a half minutes, after the water receptable had been out of the cage for 12 hours. However, I have noticed that some individuals from certain localities, particularly those far removed from springs or streams, seem to require very little water, although others will learn to drink more of it when it is supplied constantly. Of 10 individuals that I have kept in captivity, three drank freely when caught, three did not drink any measurable quantity of water at first, but learned to do so later, and four were never known to drink any appreciable quantity, although water was constantly available. Those that did not seem to drink at all used their water pans as depositories for nut shells and other rubbish, or as a latrine, a habit that Patterson also noticed. On the other hand, some individuals seemed to require large quantities of water, and during extremely cold weather when their water pans froze in a short time, they would gnaw and lick the ice until large grooves were worn in it.

Whether the "dry" animals secured enough water from their fresh food (lettuce, celery, or apples being supplied constantly), or whether they can manufacture metabolic water, as some desert rodents are known to do, is a question that awaits further research (Howell and Gersh, 1935).

One yearling female successfully nursed her single youngster without ever drinking a drop of water, so far as I could determine.

SCAT HEAPS AND SANITATION

One of the characteristics of this woodrat is its habit of leaving piles of dung, usually on some flat or slightly concave rock (pl. 2). I have seen such piles, eighteen by ten inches in extent, and at least two inches deep. The feces themselves are ovoid pellets about 11 mm. long and 5 mm. in diameter, varying according to the nature of the animal's food. The scat heaps are often placed in the most exposed places, but sometimes under shelving rocks. Frequently they have the appearance of having been used by several individuals, or over a long period of time.

Some suggestion of the nature of these piles may be obtained from the habits of captive animals, which almost invariably void their feces in a far corner of the cage, and always in the same spot. Possibly they have some instinctive sense of sanitation, although it is hard to reconcile their apparently careful observance of this habit with the behavior of a captive individual that Daniel Smiley saw eating its own scats. This rat ate four or five of the pellets in a night. Thinking that there might be a deficiency of salt or some other item in its diet, he offered it some salt, but found that it preferred the feces to the salt.

One or two of my caged specimens also departed from the usual habit of the species in that they invariably used their water pans for depositing feces, but, as I have noted elsewhere, these particular individuals apparently did not drink water. According to Patterson (1933, p. 40), a woodrat kept by him deposited its fecal waste in its drinking pan. He further wrote that the number of fecal pellets voided each 24 hours varied from 3 to 84.

I have had little success in trapping these animals in the immediate vicinity of scat piles, although they will occasionally spring traps set in the midst of a pile.

INDIVIDUAL RANGE AND SEASONAL WANDERINGS

As this woodrat is occasionally found at some distance from its usual haunts, it is possible that the animals periodically wander in search of food or of mates. There is also a tendency for the younger animals to wander in search of favorable habitat, after they are driven out of their nests by the parents.

From time to time trappers along the base of the Blue Ridge take these animals in

traps set for skunks and weasels; in November, 1932, a man brought me a specimen from Pine Grove, Schuylkill County, that had been captured in one of the farm buildings at some distance from the customary range of the species.

It is likely that this species, like other rodents, passes through cycles of abundance during which it is impelled to spread over areas that it does not usually occupy. Ordinarily it is not given to extensive travels in its search for food. My only definite observation that may indicate the extent of the individual range is limited to following the tracks of one over the snow at the Pinnacle on January 1, 1931, for a distance of over 200 yards. Fred Ulmer tells me that while trapping on Bake Oven Knob, in October, 1939, he captured one animal that contained bacon taken from another trap about a hundred yards distant.

ENEMIES

It seems strange that we have been able to learn so little that is definite concerning the enemies of this animal, since the Allegheny woodrat must furnish a rather important part of the food of many predaceous creatures, as the western species of the genus *Neotoma* are known to do. Studies of the food of predatory creatures that might be expected to feed on this species have yielded very little information.

Mr. Leo A. Luttringer (1935, p. 174) found woodrat remains in the stomach of a Cooper's hawk, although this bird must have few opportunities to feed on such a decidedly nocturnal mammal.

According to Hickie and Harrison (1930, p. 170), Blatchley, in "Indiana Caves and their Fauna," wrote that "The cats have exterminated the "rats" (*Neotoma*) mentioned by Cope and Packard as being inhabitants of Wyandotte cave."

Mr. Luther Hook, who has conducted studies in the food habits of our northeastern pit-vipers in Pennsylvania and New Jersey, has never found *Neotoma* remains in the stomachs of the timber rattler, (*Crotalus horridus*) nor of the copperhead (*Agkistrodon contortrix*), although he has examined some 70 of the former and 15 of the latter, many of which came from localities that were inhabited by *Neotoma magister*. He tells me that he has found scat piles of *Neotoma* in the dens of the rattlesnake at Torne Mountain, near Suffern, New York. W. J. Hamilton (ms. notes) mentions finding a small rattler within two feet of a nest in a West Virginia cave.

My own experience is limited to finding portions of one individual evidently cast up by a great horned owl. I have frequently observed in camping in the Pennsylvania mountains that this owl seems to hunt to a great extent along the rock ledges and cliffs that are the homes of the woodrat.

At the Schaumbok house, on the Hawk Mountain Refuge, a cave rat had a nest under the basement stairs within forty feet of a rock wall that was inhabited by a weasel, *Mustela noveboracensis*. According to Maurice Broun, both animals existed there in close proximity throughout the greater part of the winter of 1938–1939.

Rhoads, (1903, p. 91) thought that *Neotoma* seemed to defy the encroachments of the Norway rat when the two animals came in contact.

At one time I attempted an experiment to determine the mutual reactions of the two species, and placed an adult male brown rat (*Rattus norvegicus*) in a cage that was occupied by an adult male *Neotoma magister*. At first the latter received the interloper with hostility, stamping his feet, and finally pushing and boxing with his fore paws. As far as I could see no bites were inflicted by either, but the brown rat, by dint of sheer persistence, ultimately showed himself master of the situation. After six hours he was roaming around the cage, washing and feeding with the utmost nonchalance, and had usurped the nesting box, whose rightful occupant cringed in a corner. I then removed the brown rat.

It would seem, on the whole, that adult specimens of *Neotoma magister* are well equipped to cope with their normal enemies, being quick, agile, good fighters, and possessed of a keen perception of danger. Yet in spite of this fact the animal seems to have narrowed its range in recent times to the immediate vicinity of rock ledges, boulder tumbles and caves, where it is at home among the inaccessible crevices.

Among the potential enemies that have been supposed to prey upon *Neotoma magister* might be mentioned the following, although no definite instances can be cited: Fox, bobcat, skunk, weasel, and black snake.

PARASITES

Among the parasites that are known to infest *Neotoma magister* are a flea, *Orchopeas sexdentatus pennsylvanicus* (Jord.), and a mite, *Atricholaelaps glasgowi* (Ewing.). I have also found a coleopterous larva, *Cryptophagus* sp. on this rat, but this latter occurrence may have been purely adventitious. (Determinations by Dr. H. E. Ewing, U. S. Dept. Agriculture.)

W. J. Hamilton reports that specimens taken by him in West Virginia were afflicted with black Cuterebra larvae, some of which were fully an inch long and two-fifths of an inch in diameter. One female had 7 larvae in the gular region, from which the fur was practically gone.

A female that died in captivity in Reading was infested with a nematode (probably *Nematodirus neotoma*), although the direct cause of its death may have been a bad mutilation to its tail received during a fight. While these tail mutilations are frequent, and usually of little consequence, in this case the animal was probably weakened by its parasites.

DISEASES

I have noticed at least two cases of blindness. In both of these one eye was opaque (whitish or grayish in color) and apparently sightless. Whether this condition was due to accident or disease is problematical.

A case of tumor accompanied by a diseased incisor is described under "molting."

Daniel Smiley records (ms. notes) a somewhat similar case, in which the left eye exuded a grayish matter around the lids, the left cheek became swollen and the left upper incisor projected from the side of the mouth. He describes in a very interesting manner, his animal's efforts at first aid. She would brush her lips with her fore paws, and then gently scratch or brush her left eye with her left hind foot, to remove the pus. The foot was then licked clean. He later ascertained that both upper incisors were broken, "the right completely off out of sight, and the left was loose and turned freely in its socket." He later removed the loose tooth and the animal apparently recovered. Four weeks after the condition was first noticed, she was able to eat.

MOLTING AND PELAGE

There is no difference between the color of the sexes. Those in fresh winter pelage, from November to January, are darker and grayer on the back, due to a stronger admixture of fresh black guard hairs, and more ochraceous on the sides than those in summer pelage, which by March have become slightly more rufous or brownish, the black hairs fading in the meantime to a dull gray. This process of fading continuous until the general effect is of a much browner, more uniform, tone over the back. The tawniest specimen that I ever saw was a male (Reading Museum no. 1765) that fathered a litter in 1936. This was a very large and heavy animal, weighing 606 grams, showing no evidence of great age, although the teeth showed considerable wear.

Ordinarily the molt appears to progress uniformly, without developing a contrasting

pattern between the worn and fresh areas. Daniel Smiley describes an instance in which the progress of the molt was quite marked. On November 1, 1931, he wrote that in one of his specimens, "The head is all gray. The back is gray about half way back. Gray and brown meet in fore shoulders; gray in front. Upper arm gray, which extends irregularly back along the sides onto hind legs." On November 29 he wrote: "the brown (reddish) has been reduced to a triangle on rump about 2 inches in length by 1½ inches on the base, with the base about a half inch above the tail. The rest of the back and sides are gray, darkest in the middle of the back and lightest low on the sides. The legs have most of this brown."

In another instance, a female that I had in captivity developed a peculiar color pattern during the molt. About the last of November this pattern first became noticeable. The fresh dark pelage had progressed from the head and shoulders along the back, forming an acute angle which extended from the axillary regions to within a short distance of the tail. This was bordered by a pale band which separated the new dark pelage from the brownish buffy areas on the flanks. Due to the pathological condition of this individual, the molt was arrested at this stage, and continued as described until she was chloroformed in April, having had two young in the meantime. About the 10th of March this individual developed a lump on the left cheek, which proved on dissection to have been caused by a blood tumor. Her upper right incisor was also badly infected, a condition that must have existed for some time.

However, these are probably exceptional cases, both in captive specimens, and I have not noticed anything similar in my experience with wild individuals.

VENTRAL DERMAL GLAND

Down the middle of the ventral surface of both sexes in this animal there is a narrow strip on which little hair grows, while the longer hair on each side is directed mesially, partly covering the area.

In the fresh winter pelage this area is scarcely noticeable, but during the breeding season it becomes worn to a well-marked bare strip, 130 mm. long and 5 to 7 mm. wide in the broadest part. While the animals are sexually active the area surrounding this strip is continually discolored, especially in the males, with a dirty, greasy substance, partly a strong-smelling secretion of glands in the bare region, and partly dirt picked up while rubbing the parts over the rocks and ground. This they appear to do extensively, doubtless as a means of advertising their whereabouts to their companions. Those kept in captivity were frequently seen dragging the hind quarters and abdomen along the ground during the breeding season. The odor of these glands is quite marked, even in dried skins.

For an anatomical discussion of these glands the reader is referred to A. B. Howell's Anatomy of the Wood Rat (p. 16).

TAIL

The tail is hairy throughout, most of the hairs being from five to six millimeters long, although those on the tip are slightly longer, forming a pencil 7–9 mm. in length. These hairs are blackish on the dorsal surface of the tail and white on the ventral surface, creating a sharply bicolored effect.

Ordinarily the tail seems to provide a very useful balancing organ. When the animal is quietly running or walking it is ordinarily held in a fully extended and horizontal, or slightly upturned, position; during excitement, anxiety, or surprise, it is carried higher.

In fighting or feeding, when the animal assumes an upright position, the tail becomes a brace. Frequently, during excitement, it is lashed from side to side as a warning

signal. In sleeping, a very characteristic position of the animal is with the nose buried under the abdomen, and the tail curled around the feet.

TRACKS

The ordinary gait of this rat, when not hurried, is a walk, leaving a track somewhat like that of a small opossum. When running the tracks are distinctive, most resembling those of the Norway rat; but the prints of the feet are more handlike, and the last digit (little toe) of the hind foot is proportionately much longer than in *Rattus norvegicus*.

The tracks can be easily distinguished from those of the red squirrel, which they somewhat resemble in size, by their much shorter toes and nails.

SPECIAL SENSES AND ADAPTATIONS

The Allegheny woodrat is well equipped to perceive and recognize danger in the darkness that covers its usual activities. If it lacks some of the arboreal agility and dental equipment of the tree squirrels, and the fossorial ability of the chipmunk, it seems to have an unusually keen sensory equipment.

It has strikingly large ears, bright and prominent eyes, and above all, conspicuous long whiskers, of which Rhoads (1903, p. 91) wrote: "When investigating an object, [they] are vibrated with astonishing rapidity, forming a sort of halo about the face because of their incessant motion." I have frequently noticed that freshly caught individuals keep the whiskers in continuous motion while they are awake. The longest of these whiskers are about 90 millimeters, (three and a half inches) in length. It is probable that they are the seat of a highly developed tactile sense, which guides the animals in their quick and certain movements among the hazardous ledges and cliffs that they travel, often in total darkness.

The hand-like, rather fleshy feet of these rats are admirably adapted for traction when the animals are climbing among the large weathered boulders and almost vertical cliffs.

SOCIAL LIFE

Allowing a certain amount of latitude for individual variation, the Allegheny woodrat is usually a rather solitary animal and quarrelsome among its own kind. Patterson (1933, p. 40) remarked that "they seem to live in colonies," although I think that this impression may have been given by the fact that cave rats are often common wherever suitable habitats occur, rather than because of any particularly gregarious tendency.

In the wild state they are continually fighting and chasing one another, especially when food is involved. I have had one individual run into me while it was chasing another that was carrying some food. Many of the specimens that are captured are scarred or marked with signs of recent fighting. Torn ears and maimed or abbreviated tails are the commonest evidences of these nocturnal battles. According to Harry Lane (ms.), who captured several woodrats near Lebanon Pumping Station, Lancaster County, Pennsylvania, all that he caught had many scars, and one large male had lost his tail. I have taken several of these short-tailed rats, and have observed several tail injuries in captive specimens, one of which proved fatal.

Sex apparently has little or nothing to do with the fighting during the non-breeding season. Males and females will fight one another or among themselves, and the case that resulted fatally was that of a female that had two inches of skin bitten off her tail by her male cage mate, leaving the vertebrae exposed. Smiley mentions a case in which one of his rats parted with the last two inches of skin on its tail, which he had seized in an effort to capture the animal. In this case the exposed vertebrae dried up and fell off or were bitten off by the animal.

I have seldom been able to keep two of these animals together from October until late February without provoking continual fighting. In these battles the female is usually the aggressor when both sexes are concerned. During the breeding season the male is frequently bullied by the female, who drives him to a distant part of the cage and forces him to keep his distance before the young arrive and during the time of nursing. In some cases this excessive quarreling continues even through the mating season, although much apparently depends on the attitude of the female. I have seen a male at this time attempt to placate the female by bringing her crackers and other bits of food; but in several cases under observation the male seemed to be the aggressor.

COURTSHIP

Even during the period of "courtship," after a pair have accepted each other, there is a great deal of "boxing." This is not the rough-and-tumble variety of fighting, in which they clinch, bite and claw each other viciously, but a milder form of combat, in which the animals face one another on their hind legs, propping themselves on their tails, and push, scratch, or box with the fore legs. Sometimes they stand motionless and tense with excitement for several seconds, in this manner, forefeet on each other's shoulders, and whiskers vibrating.

The teeth are seldom used in these combats, although the feet often bleed and the fur flies freely. This "boxing" seems to be a necessary preliminary to mating. After the mating there is usually a brief truce, until about the time that the young arrive; then hostilities may commence again. Seldom is the relationship as amicable as in the case of a family that I kept together in 1936, when both adults and young remained in one box. After the young were able to run about, this entire family would play about the cage by the hour.

The females seem to have the hoarding instinct more highly developed than the males. They usually store great heaps of food material in or behind their nest boxes, and in several cases in winter they forced or gnawed their way into the males' boxes in order to steal their erstwhile mates' food, which was added to their own store. This food problem was apparently the cause of most of the fighting, although as the mating season approached the males would, as a rule, meekly submit to the pilfering.

In two cases, in which the pairs were together only during the mating season, there was a remarkable display of docility throughout. In both of these cases the females were apparently allowed to have their own way in matters of food and nest, and the males lived in their boxes or outside nests and seemed unusually passive.

BREEDING

Although some information is available on the breeding of other species of the genus *Neotoma*, little has been written about the present species. For instance, Goodwin (1935, p. 125) wrote that "The Allegheny wood rat mates but once a year, and the young are born in spring. A brood numbers from two to six." Marcus W. Lyon, Jr. (1936, p. 246) wrote: "They probably mate in mid-winter and two to four young are brought forth early in spring."

As a matter of fact, my experience, as well as that of others who have raised these animals in captivity, indicates that two or possibly three litters of young are raised each year, the young being born from mid-March to early September, although a juvenile specimen in the Philadelphia Academy collection (no. 10256) taken November 9, 1896 must have been born as late as the middle of October. In one case cited below the same female would have given birth to two broods about 83 days apart.

The number of young in ten litters, raised at the Philadelphia Zoo, (data from Newton Hartman), at Lake Mohonk, N. Y. by Daniel Smiley, and at Reading by myself, together

with a nest containing young found by Charles Mohr at Cascade Cave, Kentucky, averaged exactly 2 per brood, as follows:

Philadelphia Zoo (Hartman)	June 15, 1931	1
Philadelphia Zoo (Hartman)	Aug. 7, 1931	2
Lake Mohonk, N. Y. (Smiley)	Sept. 4, 1932 (?)	2
Lake Mohonk, N. Y. (Smiley	May 5, 1933	2
Reading, Penn. (Poole)	June 1, 1934	3
Reading, Penn. (Poole)	March 14, 1936 } same indi-	2
Reading, Penn. (foetuses) (Poole)	June 5, 1936 } vidual	2
Cascade Cave, Ky. (Mohr)	June 24, 1937	3
Reading, Penn. (Poole)	March 25, 1939	2
Reading, Penn. (Poole)	May 29, 1939	1

In the last mentioned case, the female was born late the previous spring, and was just one year old when her first young was born. It is probable that, as with many animals, the first is smaller than subsequent litters.

Since this species has only four (inguinal) mammae, four would be the maximum number of young that it could possibly care for. In any event the data here presented would indicate a slightly lower average than in the other species of *Neotoma* studied; *fuscipes* averages 2.8 per litter, (English, 1923 p. 6) and *Neotoma albigula* averages 2.1, (Feldman, 1935 p. 301).

While it is difficult, because of the woodrats' almost exclusively nocturnal habits, to determine the period of gestation, data collected by Daniel Smiley and myself indicate a period between 30 and 36 days.

The young weigh about 15 grams at birth (pl. 1). They are pink, naked creatures that cling tenaciously to the maternal teats. Even when disturbed the female will drag them about with her in her flight, subjecting them to many hard knocks. To facilitate this hold the young are provided, almost from birth, with strongly decurved upper incisors. This tenacious hold is maintained for the greater part of the time during the first 21 days of their life, or until the eyes are fully open. Later, the female is apparently annoyed by the persistent efforts of the young to continue their nursing.

I made no systematic attempt to weigh any of the young that were raised in captivity, thinking it best to handle them as little as possible. However the few data that I was able to gather will give some idea of the normal increase in weight with age.

	AGE	WEIGHT	LENGTH	TAIL	HIND FOOT
		grams	mm.	mm.	mm.
June 5, 1936	young about to be born	14.5	102	24	13
		14.0	101	25	13
June, 1934	age 5 days	17	121	30	18
June 23, 1934	age 22 days	40	202	86	34
April 22, 1939	age 27 days	75	260	116	40
July 1, 1939	age 35 or 36 days	90	263	113	38
June 6, 1936	age 81 days	259	377	179	43
	age 81 days	312	388	177	43
July 1, 1939	age about 1 yr.	320	430	197	42

Wild adult individuals frequently weigh from 394 to 500 grams. One fat old male that I had in captivity weighed 605 grams on June 6, 1936.

By the fifth day the young have acquired a coat of very fine silky gray hair which

increases in length until at two weeks they are fully covered with a coat of pale, silvery gray, with white feet, and a prominent black spot about the eyes.

By the fifteenth day their eyes are sensitive to light.

Sometimes as early as the seventeenth day the young are able to nibble on solid food. I tried them on various types of light foods and found that the females almost invariably selected cream cheese as the first semi-solid with which to wean them.

By the nineteenth day the eyes are beginning to open, this process being complete by the twenty-first.

On the twentieth day, the tail, which has remained hairless up to this time, begins to grow a covering of hair, which spreads from the basal portion to the tip. In two or three days this hair covering has developed over the entire length of the tail.

On the twenty-fourth day the young are usually well able to take care of themselves and to nibble on all sorts of solid foods, although they nurse, when allowed to, for at least 4 more days.

The color by this time has changed to a much darker gray; in the third month the animal assumes the buffy tone of the adult.

The age at which the young leave the nest is not definitely known, although a young male about two months old was taken along the Northkill far from any rocks on July 6, 1931. It had probably been recently driven out of its nest and was looking for a suitable place in which to settle.

At fourteen weeks the animal is practically full-grown and appears to be ready to breed, although we have no definite evidence that it ever breeds during the first season. At the age of a year, however, it is fully fertile. A young female of the season captured in July 1938, gave birth to one young on May 25 following.

The rich buffy tone of the old adult is not assumed until after two or more years; it seems to be intensified with the appearance of each subsequent new pelage.

There is very little information available on the longevity of this animal, and, since I have never attempted to keep any specimens for more than 12 months, I have no direct knowledge on the subject. Mr. Newton Hartman wrote me that an adult male captured at the Pinnacle, Berks County, Pennsylvania, on June 6, 1931, lived in the Philadelphia Zoo until August 14, 1934. This individual was therefore at least four years old at the time of its death.

GENERAL HABITS

By keeping animals of any kind in captivity, one learns that they possess a great deal of individuality. Some of the woodrats were quite friendly and tame, while others were excessively shy and would retire to their nests as soon as anyone approached at night, or whenever the light was turned on over their cages. Several would go through a variety of apparently meaningless activities, as though in play. One that was captured when quite young was given a large pasteboard box, which it pushed all over its cage throughout the night, making considerable racket in the process. It then proceeded to chew holes in the corners of the box, through which it would push its head and peep out in a decidedly impish manner. Several specimens kept by Smiley and myself would run into their nest boxes and whisk around so quickly that apparently the head was out of the box before the tail had disappeared. This was evidently done in play, or in an effort to "show off," but probably was also a reflection of some frequently practiced activity in the wild state.

One female that I tried to keep on her own side of the double cage, because she persistently raided the food supply of her mate and thereby provoked endless fighting, exercised much ingenuity in forcing her way through the half-inch wire mesh partition. After several plans to keep the animals separated had failed, I lashed a heavy wooden

block to the wire mesh along the glass front of the cage, by means of an intricately laced heavy cord. The next morning the female had removed the cord in one piece and piled it on top of her nest box, along with the eight inch length of two-and-a-half inch wood.

Practically all the animals appear at times to have a great deal of superfluous energy which is expended in carrying food and other objects back and forth, piling them up in odd places. Anything movable in their cages is apt to be dragged about or moved from place to place several times during the course of the night.

In captivity this is doubtless the expression of the tendency to carry strange objects about and hide them in odd corners, that has earned others of this genus the name of trade- or pack-rats. I have had spectacles, a fountain pen, cigars, lunch, and string stolen by these rats, and have known of a case in which the hemlock boughs used in making a bed were actually removed from the bed in which its occupant slept, and scattered far and wide.

In fine weather these animals become so active that, where they are numerous, they have given some localities the reputation, among the country people, of being "haunted." However, during inclement weather, as Kalm long ago wrote, the rats remain in the depths of their nests and rock crevices. An easterly wind is sufficient to keep the cave rat population under cover for several nights; it is more of a deterrent than extremely cold weather. After one very cold night I followed the tracks of a rat that traveled fully two hundred yards over the snow, although as a rule the animals keep to the deep crevices and caves during cold weather. Some winters I have been unable to capture any before March, when they apparently start to roam from their winter quarters.

While these rats are chiefly nocturnal, they are occasionally seen abroad during the day. This is particularly true in caves and in the larger rocky crevices; but after a long period of bad weather they often leave their nests in broad daylight for short forays after food. During favorable weather they are active from about a half hour after sunset until just before daylight, activity reaching its height about midnight. There is apparently no tendency toward the crepuscular habits observed in bats and certain other mammals. Having spent many nights on the ledges inhabited by these animals, from July through September, and watched the rats in captivity through the rest of the year under conditions as close as possible to normal, I have seen little deviation in their nightly round of activity, except that during an east wind or rainy weather they would often not appear at all, and on one occasion in September, they did not come out until near midnight, then remained very much in evidence until dawn.

They are exceedingly agile while traveling over rocks. At Bake Oven Knob they seem to have a well recognized trail up a practically vertical face of rock, which leads to a crevice at least three feet across, and which must be leaped before they can ascend to the top of the ledge. They habitually ascend and descend this crevice, leaping from one side to the other at top speed. Their rather stubby paws seem to aid them greatly in climbing over the rocks, and they are almost equally serviceable in climbing trees. I have never known them to climb vertical trees under natural conditions; but they demonstrated their ability to do so in one large cage in which I kept several specimens temporarily. Here they climbed and leaped among the sticks almost as freely as squirrels. At Cherry Ridge, Monroe County, in August, 1939, I saw unmistakable evidence that they had climbed a leaning wild cherry tree (*Prunus serotina*) to garner some of the fruit. Patterson (1933, p. 39) has noticed rhododendron twigs cut five feet from the ground, apparently the work of these animals.

They seem to defend themselves from their own kind and from enemies by means of their forefeet, which are used instinctively to thrust unwanted objects away. The case of the Norway rat cited elsewhere is an example of this habit. An amusing instance occurred one night while we were photographing the rats. Charles Mohr had

gotten up to see whether there were any rats at the bait, when one approached his stockinged foot and pushed it with its forefeet. Although I have handled a good many woodrats, I have known only one to bite. However, they are capable of inflicting a severe wound when aroused. One that was caught and placed in a bag with a red-backed mouse (*Clethrionomys gapperi*) killed the smaller animal instantly with a bite through the base of the skull.

The feet are used also in signalling; but I have never been able to ascertain whether the hind feet alone, or all four, are used in the process. They seem to signal among themselves, and evidently as a warning to intruders, as do kangaroo rats and other rodents, also rabbits. Given the proper sounding board, they can create a thump that may be heard at a considerable distance.

They frequently use the forefeet to cram food into the mouth much after the manner of a squirrel. Nuts and berries are manipulated until the jaws are as full as possible, eight peanut kernels being a maximum mouthful (Patterson, 1933, p. 39). Large objects are frequently picked up in the fore paws, or with the aid of the teeth, and carried for a considerable distance. Charles Mohr secured an interesting photograph of one carrying a sandwich in this manner.

They appear to make little use of their vocal organs. The young squeal a great deal at times in the nest, and adults occasionally squeal while fighting or when injured, but they are ordinarily little given to vocal sounds. At times they produce a chattering sound with their teeth. This sound is probably intended as a warning or threat to others of the species.

For comparatively thick-set animals they can crowd themselves into an amazingly small space. Several of my animals were fond of hiding in a space back of their nesting boxes that was scarcely 40 mm. wide. In forcing their way through the partitions to steal their neighbor's food supplies, they made many trips with nuts and other objects in their mouths, through even narrower spaces than this.

LITERATURE CITED

Bailey, V. 1923. Mammals of the District of Columbia. Proc. Biol. Soc., Washington, vol. 36, p. 115.

English, Pennoyer F. 1923. The dusky-footed wood rat. Jour. Mamm., vol. 4, no. 1, pp. 1–9.

Feldman, Horace W. 1935. Notes of two species of wood rats in captivity. Jour. Mamm., vol. 16, no. 4, pp. 300–303.

Goldman, Edward A. 1910. Revision of the wood rats of the genus Neotoma. North American Fauna, no. 31, pp. 82–86.

Goodwin, George G. 1935. The mammals of Connecticut. Bull. no. 53, State Geological and Natural History Survey, pp. 123–125.

Hamilton, W. J. 1930. Notes on the mammals of Breathitt County, Kentucky. Jour. Mamm., vol. 11, p. 309.

Hartman, Carl. 1922. A brown rat kills a rattler. Jour. Mamm., vol. 3, pp. 116–117.

Hickie, P. F., and T. Harrison. 1930. The Allegheny wood rat in Indiana. Amer. Midland Naturalist, vol. 12, no. 6, pp. 169–174.

Hine, James S. 1929. Distribution of Ohio mammals, Proc. Ohio Acad. Sci., vol. 8, pp. 260–268.

Howell, A. B. 1926. Anatomy of the wood rat. 225 pp., Williams & Wilkins Co.

Howell, A. B. and I. Gersh. 1935. Conservation of water by the rodent Dipodomys. Jour. Mamm., vol. 16, pp. 1–9.

Howell, A. H. 1909. Notes on the distribution of certain mammals in the southeastern United States. Proc. Biol. Soc. Wash., vol. 22, pp. 55–68.

HOWELL, A. H. 1910. Notes on mammals of the middle Mississippi Valley, with description of a new wood rat. Proc. Biol. Soc. Washington, vol. 23, pp. 23–24.

HOWELL, A. H. 1921. A biological survey of Alabama. North Amer. Fauna, no. 45, pp. 53–54.

LYON, MARCUS WARD, JR. 1936. Mammals of Indiana. Amer. Midland Naturalist, vol. 17, no. 1, pp. 243–247.

LUTTRINGER, LEO A., JR. 1935. Hawks—what they eat. Nature Mag., vol. 26, no. 3, p. 174, Sept., 1935.

MILLER, GERRIT S., JR. 1898. An instance of local temperature control of the distribution of mammals. Science, n. s., vol. 8, no. 201, pp. 615–618.

NEWCOMBE, C. L. 1930. An ecological study of the Allegheny cliff rat. Jour. Mamm., vol. 11, no. 2, pp. 204–211.

PATTERSON, R. C. 1933. Notes on *Neotoma pennsylvanica*, with special reference to the genital organization. Proc. West Virginia Acad. Sci., Ser. 33, no. 15, pp. 38–42.

POOLE, E. L. 1936. Notes on the young of the Allegheny wood rat. Jour. Mamm., vol. 17, no. 1, pp. 22–26.

RHOADS, S. N. 1903. The mammals of Pennsylvania and New Jersey, pp. 85–92.

SVIHLA, ARTHUR. 1932. A comparative life history study of the mice of the genus *Peromyscus*. Univ. Michigan Misc. Pub. no. 24, pp. 16–20.

SVIHLA, ARTHUR and RUTH D. SVIHLA. 1933. Notes on the life history of the wood rat *Neotoma floridana rubida* Bangs. Jour. Mamm., vol. 14, no. 1, pp. 73–74.

WARREN, EDWARD R. 1926. Notes on the breeding of wood rats of the genus *Neotoma*. Jour. Mamm., vol. 7, no. 2, pp. 97–101.

WETMORE, ALEXANDER. 1923. The wood rat in Maryland. Jour. Mamm., vol. 4, pp. 187–188.

The Reading Public Museum and Art Gallery, Reading, Pennsylvania.

A NEWLY LOCATED HERD OF PACIFIC WHITE-TAILED DEER

By Victor B. Scheffer

The existence, near the mouth of the Columbia River, of a population of Pacific white-tailed deer, *Odocoileus virginianus leucurus* (Douglas), has recently been called to our attention by game wardens in Oregon and Washington. The deer are in the same locality as those described by Lewis and Clark (1905, vol. 4, pp. 209–210; 212–213) in 1806, and by explorers who followed later, but for some reason naturalists have completely overlooked this herd in the present century. At the time when their respective accounts were published, Jewett (1914), Taylor and Shaw (1929), Bailey (1936), and Cowan (1936) considered the lower Columbia whitetails to be extinct. Nevertheless, to the farmers and fishermen who live along a certain section of the river, the "tideland deer" or "cottontail deer" are well known, and are hunted along with the black-tailed deer (*Odocoileus hemionus columbianus*) that range in the forested hills on both shores.

At four intervals during December 1939 and January 1940 we visited the whitetail range, including parts of Wahkiakum County, Washington, and Clatsop and Columbia counties, Oregon. The center of the range is about 32 airline miles from the mouth of the Columbia River. We aimed to accomplish two things. First, to obtain study specimens of *Odocoileus leucurus*, since no complete skin-and-skull specimens accompanied by field measurements had hitherto been preserved. Second, to gather evidence on the status of the lower Columbia herd. As a result, there are now deposited in the United States Biological Survey collection 23 skulls, 4 skins, 3 scalps, 11 frontlets with antlers, and 12 separate antlers of white-tailed deer from this region. The present account deals only with the status of the lower Columbia herd—distribution and numbers, food supply, mortality, and future prospects. Our notes are a combination of personal observations and interviews with long-time residents of the community. We are especially grateful to Walter Dalquest and Dave Palmer for help in the field, and to the University of Washington College of Forestry for laboratory space in which to handle our specimens.

Distribution and numbers.—The range of this subspecies is to a great extent determined by the lay of the land. Low, brushy islands and tidelands are occupied by whitetails, while the hills that rise on both sides of the Columbia are occupied by black-tailed deer and Olympic elk. There is general agreement among local hunters that whitetails seldom wander above an elevation of a few hundred feet, while blacktails are rare in the river-bottom swamps.

The present range and population of this deer along the Columbia may be described as follows: (Areas are taken from planimeter readings on United States Coast and Geodetic charts nos. 6152 and 6153, surveys of 1937–38.

The upper limit of the range is placed at the 100-foot contour where the hills start to rise sharply from the river valley.)

WASHINGTON.—Total whitetail area, 12,450 acres (19.3 sq. mi.); total whitetail population, 400 to 500, distributed as follows:

1. Along the shore from the town of Skamokawa to the town of Cathlamet, including Skamokawa Island (considered part of the mainland by residents though accessible only by bridge), Elokomin (or Alochoman) Island, and Cathlamet Island. The last two are included under the single name "Hunting Islands" on the Coast and Geodetic chart. This strip is 7 miles long by 2 miles at the widest; 5,000 acres. Ray Mooers, owner of one of the largest ranches, estimates the whitetail population of Skamokawa Island alone at 150. On January 16 we saw 31 deer, in groups of 5, 11, and 15, within a quarter-mile radius on the Mooers ranch. These animals were feeding in an open pasture with cattle. Mr. Mooers, in a letter of February 16, said that he "counted 41 out at one time lately." Also included in this range is the strip of land extending from Skamokawa Island to Cathlamet, known as Drainage District no. 4. Paul Lewis showed us the antlers of 8 whitetails taken by him in recent years in the willow thickets of these tidelands. He would not venture to estimate the size of the deer population, but said that he preferred the hunting here to that of the islands. Judging from the available food and shelter in this strip of land, we estimated that 100 to 200 animals could probably be supported. Later we were told by Harry Moe, a former game warden in Wahkiakum County (1936–39), that he checked 13 bucks out of Drainage District no. 4 during the 1939 hunting season, and that this number probably represented more than half of the total number killed in the area. He believes that there are about 250 whitetails on the Washington shore. Our estimate is 250 to 350.

2. Puget Island; $1\frac{3}{4}$ by 6 miles; 4,500 acres. Olaf Brecke, a continuous resident of the island for more than 40 years, estimates the deer population at 150; he says that 15 whitetail bucks were killed during the hunting season of October 1939. This estimate seems reasonable, judging by the amount of favorable range. We saw as many as 5 deer in one group on the Oman ranch in January. Mr. Brecke said that 2 blacktail bucks were killed on the island this year.

3. Tenasillahe Island; $2\frac{1}{2}$ by 3 miles; 2,800 acres. The lower third of this area is not diked and is flooded by spring high water; on some maps it is called Welch Island. R. L. Jones has operated a stock farm here for the last 20 years. About 15 years ago he first saw two deer around the barns with his cattle, but did not identify the species. They remained for 6 or 8 years, when one was shot; then the other disappeared. We would expect to find a few whitetails on Tenasillahe at all times. The vegetation is similar to that of adjacent whitetail range, and deer could easily reach the island by swimming $\frac{3}{4}$ of a mile downstream from Puget Island, $\frac{1}{4}$ mile from the Oregon

shore, or ½ mile from the Washington shore. Deer could also reach the island on the ice that forms during severe winters. We estimate that 2 to 5 deer occur in the wooded section of the island.

4. Price Island; ¼ by 1½ miles; 150 acres. A small, uninhabited, thicket-covered bar separated from Skamokawa Island by a tidal channel some 300 feet wide. Estimated deer population, 2 to 5.

OREGON.—Total whitetail area, 14,800 acres (23.0 sq. mi.); total whitetail population, 100 to 200; distributed as follows:

1. Along the shore from the bluff behind Wauna to the town of Mayger; 17 miles by 3 miles at the widest point; 14,300 acres. In gathering evidence on the occurrence of whitetails along the diked lands of Columbia and Clatsop counties, we were hampered by the reluctance of certain hunters to divulge information. The State Game Commission has enforced a strict closed season on whitetails for the protection of a remnant herd of about 200 to 300 animals near Roseburg, Oregon, hitherto thought to be the last individuals of this race in existence. A few persons living along the Columbia River tidelands have been accustomed to shooting whitetails, without the knowledge of the game department, during the open season on blacktails. Some of this hunting has been done by parties ignorant of the distinction between the species. Killing of whitetails has, we believe, escaped detection for two reasons: First, because of the small number of animals taken; and, second, because of the colloquial names "cottontail deer" and "tideland deer," which have tended to conceal the true identity of the animal. We believe also that certain local hunters who have recognized the deer as whitetails have kept a discreet silence in order to protect their hunting privileges in an area where whitetails are the only game animals.

Other local hunters freely offered information on the subject. Frank Berglund, of Wauna, said that tideland deer used to be common along the river between Wauna and Westport, especially in two small openings called locally "prairies." He did not see any in the fall of 1939 and he believes that they are becoming scarcer. His father, who has seen whitetails on Puget Island and knows the identifying marks, said that near Westport there used to be more blacktails than whitetails. This seems likely, considering the fact that the timbered hills are only one-quarter to one-half mile from the river at this point.

L. S. Hatton, hardware merchant, sportsman, and part-time rancher, of Clatskanie, has lived in the diked country for 20 years. He kindly gave us two sets of whitetail antlers from deer taken on the Webb and Westland Districts during 1939. The antlers had been left in his store by two hunters whose names he did not care to reveal. After comparing ideas with local sportsmen, Hatton believes that 15 to 20 whitetail bucks were taken by Oregon hunters this year; he places the total whitetail population on the Webb and Westland districts at 140. He has heard occasional reports of

blacktails on the area but has never seen one. Twenty years ago the whitetails occurred as far upstream as Mayger, Oregon, but they are now confined almost entirely to the diked lands farther downstream.

Officers of the State highway patrol, C. E. Throne and Warren Forsyth, have never heard of whitetails farther upstream than Mayger, where a rocky cliff rising from the Columbia acts as an effective barrier. From seven years' experience in this vicinity, Mr. Forsyth believes that the estimate of 140 whitetails made by Clatskanie sportsmen is "not too high."

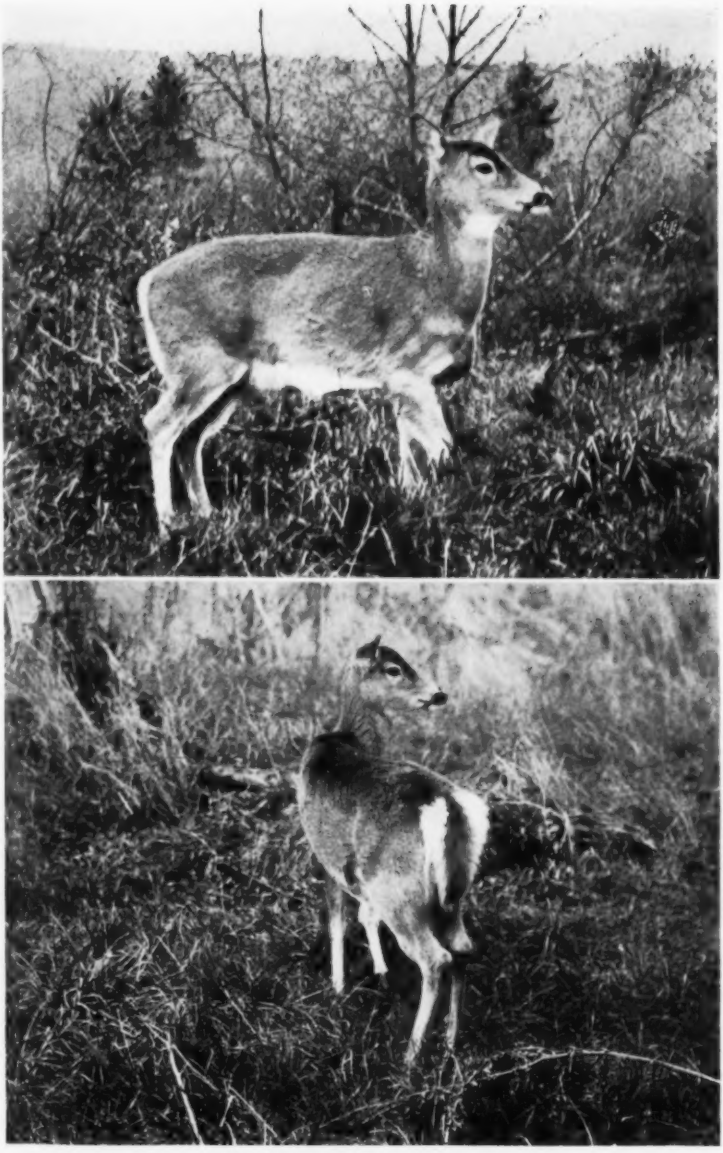
T. L. Cooper said that he saw 5 whitetails in one group in the winter of 1939–40 on the Westland District. Another rancher reported seeing three at one time. We saw 4 mounted antlers in the home of Mark Elliot.

Oregon specimens in our collection include: The 2 sets of antlers obtained from Hatton; a large skull with 4-point antlers picked up in a pasture on the Webb District; an adult doe skull donated by T. L. Cooper, picked up in 1940 on his farm in the Westland District; and a set of 3-point antlers from a buck killed (innocently) by Mr. Cooper in 1939, also on his farm.

2. Wallace Island; ½ by 2½ miles; 500 acres. We have meager information on this body of land. Four informants agreed that a Mrs. Whitcom lived on a 30-acre farm on the island for some years and that she kept a pet doe with a bell around its neck. Mr. Solberg, who lives on the nearby Oregon shore, said that there were two fawns and one buck with this doe. Solberg at present runs cattle on the island and visits the pasture every 10 days. He has seen no deer since Mrs. Whitcom left in the fall of 1938. L. S. Hatton once saw the belled doe and two fawns swimming from Wallace Island to the Beaver Drainage District; he also saw several bucks and does (species?) on the island during the duck season of 1939–40. Harry Moe, former game warden, said that he examined the belled doe, very large for a whitetail, after it was killed on the highway near Eagle Cliff, Washington. There is no doubt that whitetails have occurred on Wallace Island in the past, but there is no conclusive evidence that any are there now.

Although the two are nearly equal in size, the Washington whitetail range, as we have indicated it, carries three times as many deer as the Oregon (450:150). This is due to the fact that on the Oregon side the majority of the deer are confined to a small area on the Webb and Westland districts where considerable uncleared land remains, while over the rest of the range they are apparently thinly dispersed or in places absent. On the Washington shore and on Puget Island, owing to more favorable conditions of food and shelter, the deer are more evenly distributed.

A reconnaissance was made of the Columbia River above and below the locality where whitetails are known to occur, in order to check as accurately as possible the boundaries of the range. As far as the mainland is concerned, the four corners of the range are fixed by steep bluffs that rise from the water's edge on both the Oregon and Washington shores. According to



Upper—Pacific white-tailed deer; a doe, at least nine years old, tamed by Mrs. Jack Hovis, Puget Island, Washington. December 16, 1939.
Lower—Same deer as above showing characteristics of the tail.

Burton Lauckhart, biologist for the State game department, however, there have been occasional unverified reports from hunters that whitetailed deer occur farther downstream on the Washington shore, on the Grays River-Deep River delta. Eight whitetail bucks were reported killed there by hunters in 1939. Deer swimming the river from Puget or Tenasillahe islands and carried along by the current would find this delta the only suitable landing place along the Washington shore. Harry Moe says that he is familiar with the country around the Grays, Deep, and Naselle rivers, and that it is typical blacktail range.

In the Columbia itself there are islands up and down stream from the known range. Between Tenasillahe Island and the mouth of the river there are dozens of small islands, sandbars, and shifting promontories, many of which are visible from the Oregon highway. On a few there are scattered trees. Fishermen told us that all the islands are inundated by the combination of ocean tides and May–June flood of the Columbia. C. P. Smith, of Seaside, Oregon, game warden for this region, says that in the course of his river patrol work he has never seen deer on the islands.

Upstream, the limit of the whitetail range seems to be Wallace Island, Oregon. Still farther upstream, on Deer Island, we looked in vain for deer where, on March 28, 1806, Lewis and Clark killed 7 "of the common fallow deer with the long tail . . . upwards of 17 inches long" (vol. 4, p. 209). Superintendent Davis, of the Deer Island Livestock Company, says that he sees an occasional blacktail. Floyd Colvin, a resident of the town of Deer Island, Oregon, and for 20 years a hunter, has never seen whitetails on the island, though he is familiar with the species in the Clatskanie diked lands.

Food Supply.—The common plants that compose the vegetation of the Columbia bottomlands are listed as follows, in increasing order of their abundance:

Trees: Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), western balsam poplar (*Populus trichocarpa*), western red cedar (*Thuja plicata*). Douglas fir (*Pseudotsuga taxifolia*), and western hemlock (*Tsuga heterophylla*). The dominant conifers of the Pacific slope are nearly absent from the whitetail range.

Shrubs: Willow (*Salix* spp.), vine maple (*Acer circinatum*), salmonberry (*Rubus spectabilis*), red osier dogwood (*Cornus stolonifera*), evergreen blackberry (escaped from cultivation), snowberry (*Symphoricarpos racemosus*), gooseberry (*Ribes lacustre*), redberry elder (*Sambucus callicarpa*), hazel (*Corylus californica*). Other shrubs that are a characteristic part of the Pacific Northwest flora—devil's club (*Oplopanax horridum*), salal (*Gaultheria shallon*), Oregon-grape (*Berberis* spp.), and evergreen huckleberry (*Vaccinium ovatum*)—are rare on the whitetail range.

Non-woody plants: Sword fern (*Polystichum munitum*), saw grass (*Carex* sp.), and rushes (*Juncus* sp.). Since our survey was made in midwinter,

it was impracticable to record the presence of annuals and other succulent plants.

A large part of the whitetail range has been cleared of brush for the raising of livestock, including cattle, sheep, and goats. According to the *Cathlamet Eagle*, August 24, 1939, there are more than 1,250 cattle on Puget Island alone. The grass of farm pastures is now an important item in the diet of the deer. Of 4 deer stomachs examined during the period December 30, 1939, to January 27, 1940, all were at least half-full of soft grass and contained no traces of woody plants. Our observations on several occasions coincide with those of farmers, to the effect that the deer leave the willow thickets about daybreak and feed for several hours in the pastures, then reappear in midafternoon and feed until after dark. We, however, often saw deer feeding with cattle during the middle of the day. On Skamokawa Island, January 26, 1940, at 3 p.m., 31 deer were observed feeding in a pasture during a light rainfall. These were within a radius of a quarter of a mile. Although whitetails frequent the vicinity of pastures and buildings, they are not tame animals. We discovered that the scent of man coming down the wind was enough to cause them to retreat to a distance of 100 yards or to move back into the shelter of the woods.

The four deer examined by us (one found dead) were not in especially good condition. The largest, a 3:4-point male, weighed 118 pounds entire. In all specimens there was a noticeable lack of fat around the kidneys and under the skin. It is interesting to note in this connection the statement of Lewis and Clark that the seven whitetails killed by them on Deer Island, March 28, 1806, were "very poor, though better than the blacktailed fallow deer of the coast." Probably the condition is seasonal.

The presence of livestock on the whitetail range made it difficult to determine what animals were responsible for observed evidences of browsing. On Puget Island, December 17, an area was examined where both deer and cattle tracks were numerous. Terminal shoots of the following plants had been browsed: Willow, evergreen blackberry, snowberry, salmonberry, vine maple, and sedge (*Carex*). Sword fern growing abundantly in the area was not browsed.

Farmers are in general accord that the deer are somewhat of a nuisance. The situation is like many another familiar to game-management agents. Besides taking pasture grass and clover intended for livestock, the deer damage truck gardens. In the summer they are reported to eat the tops of peas, beans, carrots, spinach, and celery; and in the fall they root up beets, carrots, and mangels, and eat apples off the trees. When snow covers the ground they are said (Brecke) to eat the leaves of the evergreen blackberry. The snowfall in this region is moderate. In some years there is none at all, in others up to 2½ feet of snow may remain on the ground for a month. All farmers agree that damage by deer to truck gardens is greatest during severe weather.

In response to a request, a committee of the Puget Island Grange, Washington, kindly informed us, in letter of April 5, 1940, of the majority opinion of its members on the question of deer damage:

"Considerable damage is done to gardens and fruit, especially to young fruit trees. The deer bed down in mint and hay fields, causing waste in cutting. Farmers in general consider them a nuisance. Many, however, consider the novelty of having deer in their front or back yards sufficient payment for damage done.

"At the rate the land is being cleared it seems as if the cover for deer will disappear within a few years. This would probably mean that few, if any, deer will be left on the island within a period of five years. In the interest of the farmers and the preservation of the species we feel that the deer should be moved if possible."

Mortality—Man is seemingly the principal enemy of the Pacific whitetail. Eight skulls were collected from carcasses of deer that had been killed by running into wire fences, had been wounded during hunting season and escaped to die, or were does shot by hunters in mistake for bucks. Burton Lauckhart has kindly checked the records of the Washington game department and has found the following whitetailed deer reported killed by hunters in 1939: Puget Island, 15; Skamokawa Island, 7; and Deep River-Altoona, 8. Mr. Lauckhart considers the last-mentioned item questionable. The impression is prevalent, at least on Puget Island, that hunting is on the increase. With a new bridge (completed in August 1939) now giving ready access to Puget Island, such is probably the case.

Predatory animals are reported to be scarce on both the Washington and the Oregon shores. In all of Wahkiakum County, Washington, including a large forest-covered area above the river, during the one-year period April 1, 1936, to March 31, 1937, the State game department paid bounties on 3 coyotes, 41 bobcats, and no cougars. On Puget Island, according to Brecke, no coyotes, bobcats, or cougars have been reported during his lifetime, although he once saw sign of a bear. On Skamokawa Island, according to Ray Mooers, there are no coyotes. A bear appeared several years ago and dug up his pasture in three places where beef entrails had been buried. Harry Moe states that with the exception of an occasional bear, there are no predators along the Washington tidelands. Judging from the foregoing reports, the white-tailed deer are probably the least bothered by predators of any big game animals in the Northwest.

Competition for the range by other species of deer is lacking. The blacktail occurs on both sides of the river but is not adapted to the swampy conditions that have prevailed until recent years and the advent of diking. Also, the whitetail seems to be better adapted to traversing the sandbar thickets than is the blacktail. To one familiar with the latter animal, the partiality of the whitetail for going under rather than over obstructions is interesting. At first glance the well-worn trails of the white tail twisting

through the willow brush resemble those of dogs. On December 16, in a pasture, we surprised a doe with two well-grown fawns of the year. The doe cleared the top of a 4-foot fence of barbed wire, while each fawn made a quick motion, best described as a "curtsy", then ducked under the lowest stand of wire, 1 foot above the ground. On the same day we saw an adult doe go under an 18-inch barbed-wire fence. Wherever a well-traveled deer trail intersects a barbed wire fence, the barbs of the lower strand of wire invariably hold tufts of hair.

The weather along the lower Columbia may be considered inimical to the deer. The ground throughout the winter is constantly wet, either from rainfall or by sub-irrigation from the river. Fresh southwest winds from the ocean bring a mean annual precipitation of 78 inches, with a high of 102 inches (U. S. Weather Bureau records for Cathlamet, Washington). On January 26, 1940, we watched a deer feeding in the rain. Twice it shook its body as a dog does, throwing droplets of water in such profusion that for an instant the animal seemed to be enveloped in a whitish fog. When the snow melts in May and June on the headwaters of the Columbia the river rises to its highest annual peak, and, with the added effect of ocean tides, inundates all the sandbar islands near the mouth of the river. At the same season (May–July) the does are presumably dropping their young. Before the construction of the extensive dike systems in Washington and Oregon the loss of young fawns by flooding must have been considerable.

With regard to disease among the whitetails, we have the following notes: On each of 4 specimens collected in December and January, small white lice, 1 to 3 mm. in length, were present in moderate numbers. Lice from 2 of the deer (nos. 718 and 801) were identified by Dr. H. E. Ewing as *Tricholipeurus* sp., nearest *T. virginianus* Peters. In 3 of 4 deer autopsied, no internal parasites were detected. The fourth (no. 752), a young female about 9 months old, was found by Arch Silverman dead in the woods in an unbloated condition on January 14, 1940. The stomach was half-full of grass. No parasites were detected in stomach or intestines. The lungs were moderately infested with thready white nematodes 3 to 4 mm. in length lying in the bronchial tubules. Dr. G. Dikman has identified these as *Dictyocaulus viviparus*. Since a number of blood clots were associated with the presence of the worms, it is possible that the latter were responsible for the death of the deer. S. C. Whitlock (1939) states that this nematode is naturally a parasite of sheep and that its presence in deer is unusual. It is found principally in areas where sheep graze over wild land.

Olaf Brecke said that on Puget Island, before the dikes were completed (1917), a liver disease was common in cattle and whitetailed deer. The livers were described as being filled with "sand pockets" which rendered them unfit for use. The ailment is found only occasionally today. We solicited the opinion of Dr. F. D. McKenny concerning the probable nature of the disease, and he writes: "Your description would indicate that the condi-

tion was caused by the liver fluke *Fasciola magna*. The abscesses in the liver caused by this parasite are frequently referred to as 'boils' in the liver by game protectors and farmers not familiar with the disease. Cattle, sheep, deer, and elk are all frequently affected with this disease, particularly in some of the marshy areas along the coast."

Ed Erickson reported that in the winter of 1933–34 he found about 40 to 50 whitetailed deer dead along the mainland below Cathlamet. Some were in groups of 4 or 5. There were no marks of violence. A light fall of snow lay on the ground at the time. The possibility is suggested that these were poisoned by some farmer in retaliation for damage done by the deer to winter truck gardens.

J. T. Oman, of Puget Island, was forced to kill 65 cows that were positive reactors to Bang's disease (contagious abortion), out of a herd of 67 cattle. Bang's disease occurs also on Tenasillahe and Skamokawa Islands. We preserved blood from an adult male and an adult female whitetailed deer on Skamokawa Island, January 26 and 27, 1940, and carried the samples in good condition on ice to the laboratories of the Western Washington Experiment Station. Dr. C. E. Sawyer reports that both samples were found negative for Bang's disease. That the disease may actually be present among the deer is a possibility that should not be ignored. Diseased cattle in the vicinity are possible sources of contagion; and it has been shown by Tunnicliff and Marsh (1935) working with Rocky Mountain elk, that Bang's disease will affect members of the Cervidae.

Summary and conclusions.—In summary, the remnant herd of whitetailed deer on the lower Columbia is estimated to include 100 to 200 animals on Oregon soil and 400 to 500 on Washington soil. The total range includes about 40 square miles of combined island and mainland. The river is not a barrier to the free intermingling of the Oregon and Washington herds because the animals swim readily and are able to cross on the ice in severe winters. The range is low-lying, swampy, and covered largely with deciduous trees and shrubs.

The survival of the whitetails is attributed in the main to three factors: (1) Lack of competition for range by blacktailed deer; (2) absence of predatory animals; and (3) freedom from excessive hunting because of isolation from large cities.

With the gradual reclaiming of swamp lands for farm use, by diking and the clearing of thickets, the deer at first found conditions more favorable. There was less danger of fawns being drowned. An increased food supply in the form of pasture grass and farm crops became available. The deer increased to the point where their depredations were distinctly annoying to the farmers. This condition obtains on Puget Island, and to a lesser extent elsewhere, at the present time. The local grange has gone on record as favoring removal of the deer from Puget Island.

On certain diked districts in Oregon, for example, the Beaver District,

a later stage in the deer versus farmer progression is apparent. Here land clearing has proceeded to a point where spruce and willow thickets are gone and insufficient shelter remains for deer. The animals have now apparently deserted the Beaver District.

It is possible that certain diseases known to occur among livestock in the lower Columbia region will spread to and endanger the whitetailed deer. There are more than 1,250 cattle on Puget Island alone, in addition to sheep, goats, and horses. Bang's disease of cattle occurs over a wide area, although Government agents are bringing it under control. Fascioliasis is reported from sheep and blacktailed deer on the Oregon shore. Lungworms occur in whitetailed deer on Skamokawa Island.

We have described briefly the situation of the lower Columbia whitetail herds. The problem now arises, what can be done to preserve the race *leucurus* and at the same time protect the farmers whose interests in that region are steadily increasing? It is apparent that the *status quo* cannot be maintained. If the clearing of land is continued for many years at its present rate, the deer will be exterminated. To protect farm crops from deer by the use of high fences or frightening devices has been proposed, and, in fact, tried on a small scale; but we feel that under the circumstances these are nothing more than temporary expedients.

The obvious solution is to move one or more breeding stocks of the deer to nonagricultural areas. As demonstrated in the East, the Virginia whitetail is readily trapped. Where to transplant the lower Columbia deer is another problem. The site chosen should be reasonably free from predators and from competition with blacktailed deer and should be land of low agricultural value. We do not know at present of any areas meeting all these requirements. As previously mentioned, the race *leucurus* has persisted in the lower Columbia because of the peculiar topography and vegetative cover of the tidelands. Unfortunately, river bottom land is also highly desirable for farm use. Under the circumstances the logical choice of a sanctuary would seem to be a tideland area now occupied by whitetails and as yet only slightly devoted to farming, for example, Skamokawa Island, parts of Drainage District No. 4, and, in Oregon, the Westland Drainage District. If it can be shown on investigation that the cost of purchasing private lands and of constructing a few fences is commensurate with the value of preserving a vanishing race we would strongly endorse such a proposal.

LITERATURE CITED

BAILEY, V. 1936. The mammals and life zones of Oregon. North Amer. Fauna no. 55, 416 pp., 102 figs., 52 pls., 1 map.

COWAN, I. McT. 1936. Distribution and variation in deer (genus *Odocoileus*) of the Pacific coastal region of North America. California Fish and Game, vol. 22, no. 3, pp. 155–246, 63 figs., 8 tbls., 3 graphs.

JEWETT, STANLEY G. 1914. The white-tailed deer and other deer in Oregon. Oregon Sportsman, vol. 2, no. 8, pp. 5–9, 1 pl., 2 figs.

LEWIS, M., and W. CLARK. 1904–1905. Original journals of the Lewis and Clark expedition, 1804–1806, ed. by R. G. Thwaites, New York, Dodd, Mead & Co., 8 vols.

TAYLOR, W. P., and W. T. SHAW. 1929. Provisional list of the land mammals of the State of Washington. Occ. Papers Charles R. Conner Mus., Pullman, Washington, no. 2, pp. 1–32.

TUNNICLIFF, E. A., and H. MARSH. 1935. Bang's disease in bison and elk in the Yellowstone National Park and on the National Bison Range. Jour. Amer. Vet. Med. Assoc., vol. 86, no. 6, pp. 745–752, 2 figs.

WHITLOCK, S. C. 1939. The prevalence of disease and parasites in whitetail deer. Trans. Fourth North Amer. Wildlife Conference, Amer. Wildlife Inst., Washington, D. C., pp. 244–249.

Fish and Wildlife Service, U. S. Department of Interior, University of Washington, Seattle, Washington.

NOTES ON THE LIFE HISTORY OF THE SMALL EASTERN FLYING SQUIRREL

BY DWIGHT E. SOLLBERGER

Because of its strict adherence to nocturnal activity and its secretive habits in general, the common flying squirrel (*Glaucomys volans volans*) of the eastern United States has received scant attention from students of wild life. Occasionally a flying squirrel is taken in the small traps generally used by mammalogists, but since these traps are usually placed on the ground instead of on the sides of trees, the number of flying squirrels taken is small. In regions where there is considerable trapping of fur-bearers, flying squirrels sometimes become a nuisance by getting caught in traps set for more valuable animals. This is especially true of the northern flying squirrel, *Glaucomys sabrinus*, which, in the northeastern parts of United States and the adjoining parts of Canada, is likely to be abroad during the cold weather of the trapping season. Marten trappers in Montana are said to capture hundreds of the northern species in a single season (Nelson, 1918). Unfortunately these specimens seldom fall into the hands of mammalogists.

I first discovered the scarcity of information concerning the life history of the flying squirrel while I was employed as a high school biology teacher at Aliquippa, Beaver County, Pennsylvania. Flying squirrels were abundant in that region, and students were wont to ask questions concerning the "queer rats" brought in by cats.

A life-history study was planned that later developed to its present form at Cornell University as a graduate thesis. I am indebted to Professor A. H. Wright, Professor W. J. Hamilton, and Professor S. A. Asdell of Cornell University for many valuable suggestions during the course of this investigation.

In the vicinity of Ithaca, New York, the ranges of *Glaucomys volans* and

Glaucomys sabrinus overlap. Dr. W. J. Hamilton told me that he has taken the northern species in the gorge of Fall Creek adjoining the north end of Cornell University Campus, and the southern species in the ravine formed by Cascadilla Creek at the southern extremity of the campus. A male of the northern species was captured alive in a wood-lot near McLean, New York, approximately fifteen miles northeast of Ithaca. Forty-seven flying squirrels that I collected or observed within three miles of Ithaca were *Glaucomys volans*. Specimens in the Cornell University Museum indicate that the northern species is usually found at the higher elevations.

No specimens of *Glaucomys sabrinus* were taken in the areas that I studied in western Pennsylvania. However, Doutt (1930) and Green (1930) took this species in Pennsylvania, and Miller (1936) described a new subspecies from the mountains of West Virginia. Irving Knobloch, park naturalist of Allegany State Park, in extreme southwestern New York, informed me that he had taken *Glaucomys sabrinus* in that park, where I have personally taken *Glaucomys volans*.

HABITAT

Flying squirrels are essentially animals of the mature deciduous forests. However, the northern animal inhabits the coniferous forests; and where it occurs in Pennsylvania and New York, this species is to be looked for in the islands of Canadian life that are found to the south at suitable elevations.

The eastern flying squirrel occurs most commonly in climax forests of the beech-maple type. Cavities that provide suitable nesting places are numerous in such forests, and there is usually an abundance of nuts, which form a large part of the animal's diet. The part of the woods near the Rifle Range at Cornell University, where many flying squirrels were taken, is essentially beech-maple in character, although a considerable number of other trees are present.

MEANS OF DETECTING THE PRESENCE OF FLYING SQUIRRELS

Trapping.—The most productive method of detecting and collecting flying squirrels is to nail Schuyler rat traps to the trunks of large trees and bait them with hickory nuts. Sumner (1927) used this method to collect material for a study of the San Bernadino flying squirrel. The traps should be fastened as high as possible, because in gliding from tree to tree, flying squirrels often strike the trees twenty feet or more from the ground and then climb upward. The traps set on hemlock trees caught approximately as many squirrels as those on all other trees taken together. There was little choice in the selection of the remaining trap sites, as squirrels were caught in about equal numbers on all other kinds of trees. The traps were usually set late in the afternoon, although on many occasions it was more practical to leave them in place as long as they continued to catch squirrels. Red squirrels, gray squirrels, chipmunks, and deer mice were caught in the same traps.

Live trapping.—In order to secure living animals, wire cage traps and improvised tin-can traps, such as were designed by Burt (1927), were used. After a nesting site had been discovered, it was usually a simple matter to capture the animal by placing four or five traps of either of these two types, on nearby trees. Hickory nuts proved to be the most effective bait.

Sounds made by flying squirrels.—During the night it is possible to detect the presence of flying squirrels in a given locality by listening for their faint squeaking notes. These notes suggest the "chipping" of a small bird. They have some of the explosiveness of the chipmunk's notes, but not nearly the volume. When producing these sounds, the animals were often found to be located on the trunk or larger branches of a tree. Their eyes shine with a reddish-orange light when a flashlight is held in such a way as to reflect the light to the observer. If specimens are desired, the animal may be shot by taking careful aim at the shining eyes. Number nine shot with a .410 gauge shotgun proved most satisfactory. The presence of flying squirrels may be detected in this manner when the most careful daylight search will not reveal a single animal.

Knocking on trees.—Another way to find flying squirrels is to pound on old tree trunks that contain woodpecker holes or other suitable cavities. This method seems to be most productive in spring, when the females are nursing their young. Although it is often mentioned in print, I believe that it has little to commend it. The energy expended in working over an area of woodland in this manner is out of all proportion to the results obtained.

Nuts opened by flying squirrels.—It is sometimes possible to find hickory nuts that have been opened by flying squirrels in a characteristic manner. Such nuts may be easily distinguished from those opened by other rodents. Flying squirrels make one elliptical opening in a hickory nut through which they are able to extract the contents. This opening is roughly circular or elliptical in outline, depending somewhat on the size and shape of the nut. The edges of the opening have the appearance of being ground off rather than being broken off in pieces. Red squirrels sometimes open hickory nuts in a similar manner, but the edges of the opening are much rougher. Gray squirrels and chipmunks cut the nuts into many pieces, leaving only fragments. Deer mice make an opening on each side of the nut.

Feeding in nut trees.—During October, when the flying squirrels are busy in the hickory or white oak trees, it is possible to locate them at night by the shaking branches and dropping hulls. Later, when the nuts have dropped, flying squirrels come to the ground and may be located by the rustling of the leaves as they search for the fallen nuts.

INTERRELATIONSHIPS OF SPECIES

The number of flying squirrels found in holes made by the downy woodpecker (*Dryobates pubescens*) indicates that these birds play an important

part in the lives of flying squirrels. In localities where there are many large-toothed aspens, the work of the downy woodpecker may be especially abundant, and these areas, if close to nut-bearing trees, usually yield many flying squirrels.

I have obtained few data concerning the animals that prey on the flying squirrel. However, judging from the number of times that house cats have been reported as bringing in flying squirrels, this predator must be listed among those most destructive in areas close to man's habitations. Man is probably the flying squirrel's most serious enemy. In areas where forests are not cut the practice of clearing out dead trees tends to limit the number of available nesting sites.

TIME OF ACTIVITY

Flying squirrels are among the most nocturnal of American mammals. During the course of this study no flying squirrels were seen during the daylight hours except those that had been frightened from their nests. Audubon and Bachman (1846, p. 218) had the unique experience of watching two hundred of these creatures begin their nocturnal activities "during the half hour before sunset." Kennicott (1857, p. 69) observed flying squirrels on cloudy days. Kelker (1931, p. 166) observed a pair mating at 4 p.m., March 12, near Ann Arbor, Michigan.

I have had several opportunities to watch nesting females come from their nests. This they did while there was still sufficient daylight to barely see them at a distance of twenty feet. When listening for them among the trees, I have found that it has always been completely dark before any were heard, but from the time they emerge from their diurnal slumber until just before daylight, their activities seem never to cease. King (1883, p. 37) observed two periods of activity in his captives, one beginning at 10:45 at night and one at 3:30 in the morning, each lasting from an hour to an hour and a half. Ballantyne (1889, p. 34) says that he knew of a pet flying squirrel that was active from two to four o'clock in the morning only. I have observed caged animals during every hour of darkness at various times throughout the summer months without noticing any change in the degree of activity until just before daylight, when they returned to their nest box.

DEGREE OF INACTIVITY IN WINTER

Opinion differs among naturalists as to the degree of activity of the small eastern flying squirrels in the winter. Much of the lack of agreement could be overcome if the species under discussion were made clear. There is no doubt that the northern flying squirrel remains active throughout the winter. Although I found no torpid animals, my observations indicate that the smaller species, however, is inactive during the colder weather. The following evidence is submitted: On January 18, 1935, a thorough search was made

of a woodland tract of approximately four acres' extent near Aliquippa, Pennsylvania. No squirrels were located. One week later, on January 25, 25 tin-can traps were placed on trees in the same area. These traps were allowed to remain on the trees until late spring and were kept baited. No flying squirrels were caught until the first week of April, when three were taken. During the month of April a total of 14 flying squirrels was taken in these woods. Five more were captured by hand during the first week of May.

At Ithaca, New York, on December 24, 1935, 60 rat traps were placed on trees in Six Mile Gorge. These traps were kept baited and were allowed to remain on the trees until March 11, 1936. On January 11 two male flying squirrels were taken from the traps. The average daily temperature at the Cornell University weather station for the week preceding this catch was 32.2 degrees Fahrenheit. No squirrels were then caught until March 11, when 3 were taken. The weather in the interim had been exceptionally cold, the average daily temperature for the period between January 11 and March 4 having been 19.6 degrees Fahrenheit. Just before March 11 the weather became warmer, the average daily temperature for the week preceding this date having been 33 degrees. The temperature for March 10, the day preceding the catch, was 42 degrees.

During January, February, March, and April of 1935, 1936, and 1937, a more or less constant search was made for flying squirrels, as I was anxious to secure living females for breeding purposes. No squirrels were found until April. No animals were caught in traps during February of any year during this study. However, as will be shown later, breeding records indicate that mating takes place during the latter part of February and early March.

Hibernation, such as occurs in chipmunks, groundhogs, or jumping mice is not characteristic of flying squirrels. Persistent trapping during January and February would, no doubt, result in the capture of some flying squirrels, especially during the warmer weather of this period.

MOVEMENT

Running on the ground.—Flying squirrels are not rapid runners on the ground. Repeated timing of captives showed that they could cover approximately 75 feet in 12 seconds. The ground at this time was covered with one-half inch of snow which could possibly have impeded their speed. It is not probable that flying squirrels could cover this distance in less than 10 seconds under the best conditions. This is about two-thirds the speed of red squirrels under similar conditions.

Flying squirrels are not adept at dodging about on level ground. It is a fairly simple task to pick one up after it has been released on either short grass or a thin coating of snow. In tall grass they are almost helpless, and usually they attempt to hide instead of to escape by running. Even in the woods where the forest floor is covered with the usual debris it is possible to

catch them by hand after they have been shaken from small trees or shrubs where they have taken refuge. In most instances, however, the squirrels are clever enough to make for the nearest large tree, which, when reached, provides security from capture.

Climbing and other movements in trees.—Flying squirrels are obviously highly specialized for an arboreal existence. Whereas red and gray squirrels spend much time on the ground, feeding on fallen nuts, flying squirrels are able to glide to trees 50 yards away without touching the ground. Observations of flying squirrels on the ground are rare since the animals hurry to the nearest tree as rapidly as possible when one approaches them. Coventry (1932, p. 75), however, observed the northern flying squirrel carrying food a distance of 30 to 40 yards along the ground.

Once a flying squirrel reaches a large tree, it is safe from capture, at least by man. Red squirrels are experts in the trees, but they seem somewhat awkward compared with the agile flying squirrel. Especially on the trunk and larger branches does the flying squirrel excel. If a flying squirrel is found in a small tree or shrub, it may be captured by shaking the tree and thus causing it to drop to the ground. This is especially true when the animal is among the smaller branches. On windy nights no flying squirrels were seen in the woods. Captive flying squirrels released on small trees on windy nights did not attempt to glide, although they did not hesitate to do so on quiet evenings.

Gliding ability.—Many naturalists have reported on the gliding ability of the flying squirrel. Audubon and Bachman (1846, p. 217) tell of seeing flying squirrels glide fifty yards from the top of a tall oak. King (1883, p. 37) describes a tremulous motion of the fore limbs just before alighting. Evermann and Clark (1920, p. 478) and Stack (1925, p. 128) observed females carry their young while gliding. Klugh (1924) observed a squirrel glide more than 100 yards down a slope. Brewster (1937, p. 19) tells of seeing a flying squirrel turn to one side to avoid a twig while in flight.

Flying squirrels have considerably more gliding ability and control of their gliding than is generally supposed. Animals were seen at night to take off from practically the same spot and glide at very different angles, depending upon their destination. They were also seen to avoid obstacles by turning to one side or by elevating their glide. Turns of more than 90 degrees were observed on many occasions. In one instance the animal was observed to glide down a steep slope for approximately 75 feet. It then turned at right angles to its former direction and glided parallel to the slope, finally turning and landing on a tree on the slope slightly above the lowest point of its glide. The total distance covered in this glide could not have been less than 125 feet.

The upward turn at the end of the glide seems to be a normal but not a necessary part of each glide. This turn decreases the speed of the glide, so that the jar of landing is not so great as to cause injury. At the end of a

long glide the flying squirrel turns upwards at a steep angle, sometimes stopping on the trunk at the place of landing, and at other times running up the tree for a distance of ten or fifteen feet with scarcely a pause between gliding and climbing.

When about to take off, the animal lowers its head and gathers its legs under itself for as strong a leap as possible. In the take-off the forelegs are extended as soon as they are away from the supporting structure. The tail, which, as the animal takes off, is elevated over the back, is pulled downwards vigorously. The purpose of this motion is difficult to see, since the entire process is very rapid. The membrane is not extended tightly but is permitted to balloon somewhat, especially near the end of the glide. Modifications of the tension of the patagium are probably used along with the tail in changing the direction of flight. I have not observed (under natural conditions) the feet and tail to vibrate as happens with red and gray squirrels. Captive animals sometimes make various motions with the feet and tail in order to right themselves after being thrown into the air.

The upturn at the end of the glide could be brought about by an upward motion of the tail which seems admirably fitted for the purpose. However, this motion could not be detected in gliding animals. Motion pictures taken at the rate of sixty-four frames per second were too slow to record the various motions of the animal.

On a short glide that is half a leap and half a glide, the animals are able to maintain an almost horizontal position. This is done when the squirrels jump to a tree five or six feet distant. Experiments with captive animals revealed that from the top of a pole 8 feet high, 10 feet was the maximum distance that could be reached, measured horizontally. Thus at this elevation the best the animal could do was to glide at an angle of 40 degrees from horizontal. However, with increased height and momentum, probably 30 degrees represents the maximum that could be attained in still air.

Captive flying squirrels were repeatedly observed to glide to the ground from elevations up to 20 feet, but this procedure was not observed under natural condition. Hickory nuts placed on top of a shelf 15 feet from the ground were quickly carried to the ground on a short glide. The weight of the hickory nut did not appear to affect the angle of the glide.

One flying squirrel was observed to glide 152 feet from an elevation of not more than 60 feet, landing 4 feet from the base of a tree. The squirrel then returned to the tree from which it started. This procedure was repeated several times, although on the return trip the squirrel was able to reach a greater height from which to glide. This is the longest glide I have observed.

VOICE

Flying squirrels make at least three sounds. One is a very soft "tssep," somewhat like the "chip" of a small bird. Another note is similar to the

first but much louder. These two notes may be heard in the woods at night, especially in the cool nights of October in the regions where this study was conducted. The third note is simply a squeal uttered when the animal is in distress, or when its nest is being intruded upon. This note is usually accompanied by efforts to scratch or bite. I have never heard the "chuck, chuck" mentioned by Nelson (1918) and Wood (1910, p. 535). The first sounds heard from young flying squirrels are whimpering cries uttered a few minutes after birth. These sounds invariably cause the parent to look after the young. Young white rats produce an almost identical note; hearing which, a parent flying squirrel shows the same concern over the squeaking young rat as it does over its own young.

Female flying squirrels under natural conditions respond quickly to the squeaking sound of the young or to their imitation. A female with a litter of four in a dead poplar stump braved the light of a gasoline lantern to search about for the cause of the sound I was producing. Once during the search she climbed on my foot to sit there for 15 seconds before resuming her search. The male was not seen. Neither the captive male nor the male in natural conditions makes any response to the cries of the young.

At night in the woods it is often possible to find flying squirrels by listening for their notes. Discovery can sometimes be facilitated by throwing stones toward the place where the squirrels are thought to be. This causes the animals to "tssep" more vigorously. It appears that the louder of the squirrel's two notes is an alarm note. On several occasions when my captives were quietly feeding, one of them would produce this loud note, whereupon all would run up the sides of the cage and "freeze" in various positions. Absolute immobility would be held for several minutes, at the end of which time the animals would gradually start to feed. On at least three different occasions this behavior was observed when a dog approached the cage. At other times there did not seem to be any obvious cause.

FOOD

The food of flying squirrels as recorded by various authors consists of nuts, seeds, corn, salt, sugar, birds, birds' eggs, beef, berries, acorns, birch catkins, beetles and other insects of various kinds.

My own observations indicate that hickory nuts are the preferred food of flying squirrels in the fall of the year. On the cool nights of September and October one may hear the squirrels in the trees, busily garnering nuts for immediate and future needs. White oak acorns are also highly prized if one is to judge by the frequency with which squirrels are seen in white oak trees.

Flying squirrels were observed to root about the ground while feeding, but the nature of the food found there could not be determined. In the spring they were seen feeding on the blossoms of the sugar maple. E. C. Raney and George Hollibaugh observed flying squirrels congregating in juneberry

trees (*Amelanchier canadensis*) in June near Mercer, Pennsylvania. Captive squirrels ate juneberries freely. J. G. Franclemont, while collecting night flying insects in Six Mile Gorge at Ithaca New York, found flying squirrels eating the bodies of moths that had been attracted to the sugared trees.

In addition to nuts of all kinds, captive flying squirrels ate apples, dried apricots, grapes, prunes, peanut butter, grasshoppers, moths, beetles, suet, ground beef, liver, boiled egg, milk-soaked bread, corn, oats, wheat, dead birds, live birds, apple and beech twigs, and buds of apple, pear, sugar maple, and black birch trees.

Food storage.—The instinct for food storage is well developed in flying squirrels. This is recorded by Brickell (1737, p. 128), Audubon and Bachman (1846, p. 220), Kennicott (1857, p. 70), Abbot (1885, p. 54), Lottridge (1906, p. 57), Comstock (1914, p. 89), and Brownell (1923, p. 290).

I have seen flying squirrels carrying nuts at night in the fall, but it was impossible to follow them to their destination and discover their hordes. Food storage is begun while the nuts are still on the trees, and a person walking along beneath is sometimes startled by the dropping hulls of hickory nuts. Later, when the nuts and the leaves have fallen, flying squirrels may be observed running up the trunk with hickory nuts in their mouths. A glide from the top of a tree into the surrounding darkness baffles the most persistent efforts to follow the squirrels. Later, the same or a different squirrel may be seen returning to the same tree in order to gather more food for the storehouse. When the nuts have fallen the squirrels search the ground for nuts that escaped them in the treetops, and the rustling of the leaves on the forest floor will sometimes guide one to the animals while thus engaged. Wild squirrels were not observed to bury nuts, but that they do so is probably the case, since captive animals released in an open field quickly buried the nuts that were supplied them. In order to carry the nut, the squirrel gnaws at it a little to secure a firmer hold, then bounds away to bury it. The burial is very superficial, the nut being scarcely hidden. The grass and dirt is pulled aside with the forefeet, and the nut is pushed down with the mouth. While doing this the animal crouches over the nut, pushing it well down between the hind feet. Then, with a few careless movements, the nut is partially or entirely covered, and the animal returns to the unburied nuts to repeat the procedure. Worthless nuts are not buried.

Dependence on water.—Flying squirrels were never observed to drink water under natural conditions. In captivity they take water or milk eagerly at all times. Three-fourths of a cup of milk or water will be consumed by eighteen flying squirrels in one night in the summer. If without liquid for a night, the animals come from their nest box to crowd around the saucer of milk or water at mid-day, climbing over each other in their eagerness to get the liquid. Lack of solid food does not cause this response. I resorted to

milk entirely as a liquid for the squirrels in order to insure a more adequate diet. In winter, liquid does not seem nearly so important to them. Approximately one-third as much milk, or even less, is consumed in winter during a given period of time.

Flying squirrels are not nearly so hardy as are gray or red squirrels. They are not tenacious of life, and one must be careful in handling them since too great pressure on their soft bodies or a light blow may be fatal. Very slight shot wounds or slight wounds from the teeth of another squirrel are often fatal.

TEMPERAMENT

The playful and confiding disposition of flying squirrels has been discussed in literature so frequently that little can be added to what has already been written. If a wheel is placed in the cage in which these animals are confined, it is kept going continuously and seemingly for nothing but the enjoyment of the exercise. Without the wheel, the animals will dart about the cage in the most bewildering fashion, scarcely ever ceasing their motion. There are few American mammals that exhibit such ceaseless activity. This is especially true during the nights of September and October.

When handled, flying squirrels usually bite, especially if held tightly and in such a way that they can reach one's fingers with their teeth. If picked up by the loose skin or held lightly in the cupped hand, they may be held more safely; but in either case it is best to wear gloves. Wild squirrels taken from a hollow tree or wire-cage trap are unable to bite through a common canvas glove. They are able to bite through thin leather gloves, such as kid or pigskin. By holding the animal's head between thumb and forefinger the danger of being bitten can be in a large measure avoided.

Females are much less likely to bite at the time of nursing than at other times. I have then repeatedly handled them without gloves, and although they may put their teeth on my fingers, they do not bite hard. They allow themselves to be pushed aside in order that a young one may be taken from the nest for inspection; but once the young animal is lifted where the parent can see it, she attempts to grab it with her forefeet and teeth. Care must then be taken lest she bite the young so hard as to cause injury.

During the daytime their disposition is as dull as it is lively during the night. The animals retire to their nest in the early morning hours and do not come out again until early evening. If frightened from their nest during the day, they glide to a nearby tree and sit at the base without moving; or perhaps they will run 10 or 20 feet up the tree and stop. In this position they sit until the observer becomes weary of waiting for signs of life. Their inconspicuous coloration makes it difficult after a time to be sure whether it is actually the squirrel that one sees. After a varying period of time, up

to two hours, a squirrel will suddenly come to life, run to a convenient branch, and glide to the nest tree where it returns to its nest and resumes its interrupted rest. The entire procedure is dull and lifeless as compared with the intense activity at night.

Individual differences.—Although the above facts apply to flying squirrels in general, occasionally in captivity one becomes vicious. I well remember one captive that would bite at every opportunity. While others made no attempt to escape when food was being placed in the cage, this animal would constantly dart through the door so quickly that it was impossible in many instances to stop it. When the nest box was opened it would turn on its back and attempt to drive out the intruder. During this time the remaining animals would attempt to hide their heads by pushing between their associates.

A captive released for the purpose of making tracks in the snow for observation, ran until tired then turned and faced the pursuer, standing on his hind legs only, as if ready to fight. After a few seconds in this position, the animal once more attempted to escape by running away.

Sanitation.—Fecal material is scarcely ever deposited in the nests by flying squirrels. A female with young was observed to glide to a tree fifteen or twenty feet away to urinate. Defecation was not noted. Examinations of many nesting sites showed very few scats in the nests. This was true of adult males as well as of females with litters.

In confinement the squirrels have been seen leaving their nest to defecate regularly in one corner of their cage. This habit continued until a small heap of scats was formed.

Reaction to sound and light.—Flying squirrels at times seem to be little affected by voices or motions of humans. Light will usually cause them to hide, but this is not always the case. Frequently while walking in the woods at night carrying a lighted flashlight, no effort being made to be quiet, I have seen flying squirrels glide from a distant tree to one nearer to me. J. G. Franclemont, while collecting night flying insects in Six Mile Gorge near Ithaca, New York, observed flying squirrels gliding to the trunk of a tree on a branch of which his gasoline lantern was suspended. It was his habit to stand beneath the lantern and swing his collecting net to intercept flying insects, and even this procedure did not prevent flying squirrels from coming close enough to be seen.

However, they are not entirely devoid of fear, as I have frequently observed them very skillfully avoiding the light from a flashlight. The report of a .410 shotgun will usually quiet their voice for several minutes. Captive animals soon become indifferent to almost any activity outside their cage. Females with young will brave almost anything to recover young taken from the nest.

LITERATURE CITED

ABBOT, CHARLES C. 1885. A Naturalist's Rambles about Home. New York, D. Appleton and Co., pp. 51–57.

AUDUBON, J. J., and JOHN BACHMAN. 1846. Quadrupeds of North America, vol. 1, pp. 216–222.

BALLANTYNE, J. 1888. Our squirrels. Ottawa Naturalist, vol. 2, no. 3 pp. 33–44.

BREWSTER, WILLIAM. 1937. October Farm, pp. 18–20, Cambridge, Mass.

BRICKELL, JOHN. 1737. The natural history of North Carolina with an account of the trade, manners, and customs of Christian and Indian inhabitants.

BROWNELL, L. W. 1923. How our squirrels pass the winter. Nature Magazine. vol. 2, pp. 289–291.

BURT, W. H. 1927. A simple live trap for small mammals. Jour. Mamm., vol. 8, pp. 302–304.

COMSTOCK, ANNA BOTSFORD. 1914. The Pet Book, pp. 87–90. Ithaca, New York.

COVENTRY, A. F. 1932. Notes on the Mearns flying squirrel. Canadian Field Nat., vol. 46, pp. 75–79.

DOUTT, J. KENNETH. 1930. *Glaucomys sabrinus* in Pennsylvania. Jour. Mamm., vol. 11, pp. 239–240.

EVERMANN, B. W., and CLARK, H. W. 1920. Lake Maxinkuckee, a physical and biological survey, vol. 1, pp. 477–479.

GREEN, M. M. 1930. A contribution to the mammalogy of North Mountain Region of Pennsylvania, Ardmore, Pennsylvania. Privately published.

KELKER, GEORGE. 1931. The breeding time of the flying squirrel (Glaucomys volans volans). Jour. Mamm., vol. 12, pp. 166–167.

KENNICOTT, ROBT. 1857. The quadrupeds of Illinois injurious and beneficial to the farmer. U. S. Patent Office Rep. (1856), pp. 52–110.

KING, F. H. 1883. Instinct and memory exhibited by the flying squirrel in confinement, with a thought on the origin of wings in bats. Amer. Nat., vol. 17, pp. 36–42.

KLUGH, A. B. 1924. The flying squirrel. Nature Magazine, vol. 3, pp. 205–207.

LOTTRIDGE, SILAS A. 1906. Familiar Wild Animals. New York. Henry Holt and Co. pp. 54–63.

MERRIAM, C. HART. 1884. The mammals of the Adirondack region, northeastern New York, pp. 197–206.

MILLER, GERRIT S., JR. 1936. A new flying squirrel from West Virginia. Proc. Biol. Soc. Washington, vol. 49, pp. 143–144.

NELSON, E. W. 1918. The flying squirrel. National Geographic Mag., vol. 32, pp. 466–468.

STACK, J. W. 1925. Courage shown by flying squirrel, Glaucomys volans. Jour. Mamm., vol. 6, pp. 128–129.

SUMNER, E. L. 1927. Notes on the San Bernadino flying squirrel. Jour. Mamm., vol. 8, pp. 315–316.

WOOD, F. E. 1910. A study of the mammals of Champaign County, Illinois. Bull. Illinois State Labor. Natural History, no. 8, pp. 534–536.

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PERIODIC FLUCTUATIONS IN NUMBERS OF THE RED FOX IN ONTARIO

By E. C. Cross

Fur traders and trappers have long known that fur-bearing animals are at times abundant and at other times scarce. Such alternating periods of abundance and scarcity are of primary importance to those engaged in the fur trade. Biologists also have been interested in such fluctuations in animal numbers and a considerable literature has grown up around the fur records of the Hudson's Bay Company, wherein periods of abundance and scarcity in the Canadian fur trade have been traced for more than two hundred years.

Perhaps the fact that the Company's fur sale records were made up of furs collected throughout the length and breadth of Canada has led investigators to think of these fluctuations in numbers as a sort of continent-wide biological tide, rising and falling periodically. In any event, Seton, Hewitt, Elton and others, who have published curves prepared from the Hudson's Bay Company's fur sale records, appear to have considered that any periodicities shown were inherent biological periodicities of the fur-bearers of Canada as a whole.

Various data in the Royal Ontario Museum files have seemed to suggest that, in Ontario at least, periodic fluctuations in the numbers of fur-bearers are not even province-wide, but are definitely regional phenomena. Accordingly, when, through the courtesy of the Hudson's Bay Company, the fur returns of each of the Company's Ontario posts were given to the Royal Ontario Museum of Zoology for study, it was decided to investigate the variations in numbers, within the province of Ontario, of the more important fur-bearing animals.

The present paper is restricted to a consideration of the fluctuations in numbers of the red fox (*Vulpes fulva*).

MATERIAL

The Hudson's Bay Company maintains two types of posts in Ontario—"Trading Posts," which are year-round establishments having a permanent staff, and "Outposts," which are temporary extensions of the parent post. The fur traded at the outpost is included in the return of the parent post; but from time to time outposts have been advanced to the status of trading posts and a separate annual return of furs traded is thereafter made by the new post. In this paper the fur returns of such newly established posts have been included with those of the parent post, until the turn of the cycle during which such administrative change occurred.

Furs are not drawn uniformly from all areas in the vicinity of the post; but the pelts traded at each post from year to year may be considered a fairly dependable indication of the numbers of fur-bearers in the surrounding territory. Caution has been exercised in using the returns from posts having a

yield of pelts so low that local conditions among the trappers might have materially affected the figure. Without too serious question, then, the number of fox pelts traded at a post may be accepted as an index to the density of the fox population of the area from which the post draws its furs.

The fur returns for Ontario cover the period from 1916 to the present and represent the actual numbers of pelts traded at each post during the "outfit

FIG. 1. Location of the Hudson's Bay Company's posts in Ontario

year." An outfit year extends from the first of June to the thirty-first of the succeeding May, the year being recorded as that at the time of closing the books.

These records cover a period of twenty years, a total of thirty-four trading posts (see figure 1) and more than one hundred thousand fox pelts.

FLUCTUATIONS IN NUMBERS OF ONTARIO FOXES

Curves prepared from the total annual sale of fox pelts received by the Hudson's Bay Company from all their Canadian posts have been regarded by

Seton, Hewitt, Elton and others as demonstrating a country-wide periodic cycle for the red fox in Canada. When the total annual returns for all the Company's Ontario posts during the period under review are similarly compiled and plotted against the years as in figure 2, three well-marked periods of abundance and two periods of scarcity for Ontario foxes appear to be shown, the maxima being in 1917, 1926, and 1936 and the minima in 1920 and 1931. Expressed in percentage with the earliest peak, that of 1917, taken as 100%, the drastic nature of the fluctuation in the catch of foxes may be seen.

The marked increase in the catch of foxes as indicated in table 1 (wherein the total catch for 1936 is three times that for 1917) does not necessarily represent a similar increase in the fox population of the province. The fox has been able to hold its own in partially settled areas, despite increased pressure from man; and indeed in some districts it appears to have increased. The very marked rise in catch at the peak of abundance, however, has been due in large measure to the establishment of trading posts in new territory.

TABLE 1.—Comparison of fox pelts collected by the Hudson's Bay Company in Ontario during the years of greatest abundance and scarcity, expressed in percentage of 1917 collections

1917	100%
1920	10%
1926	278%
1931	35%
1936	307%

Almost double the number of posts present in 1916 are now operating in northern Ontario.

Inspection of the returns from individual posts for the period 1916 to 1938 revealed that the numbers of foxes traded at each post were at times high, at other times low. But on comparing these individual returns with the curve in figure 2, a marked lack of uniformity was apparent. It was evident that there were wide variations as to the years in which the maximum numbers occurred, the years in which the minimum numbers occurred and in the intervals between these years.

YEARS OF MAXIMUM NUMBERS

The number of major peaks for each post and the years in which they occurred were tabulated. The percentage of the posts reaching maximum numbers in any one year was then calculated. The results are shown in table 2.

It may be seen from this table that there is wide variation as to the number of years in which maxima occurred, that the number of posts reaching maxima in any one year range from a minimum of 3% to a maximum of 52% and

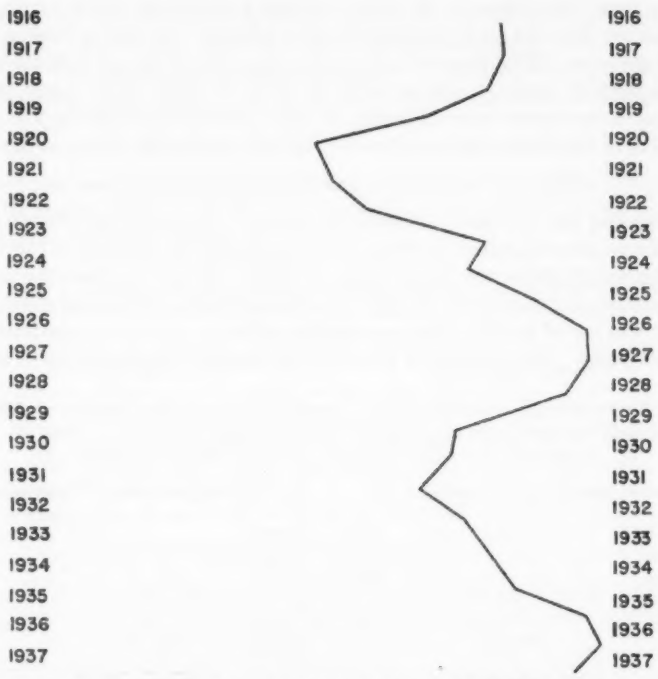

FIG. 2. The total annual returns from 1916 to 1937 of the Hudson's Bay Company's Ontario posts are shown plotted against the years of return. Semi-logarithmic paper has been used in the preparation of this graph. The number of pelts has been plotted along the logarithmic axis and the years along the arithmetic axis. This type of graph paper has been used throughout the study of the Hudson's Bay Company fur figures because of its practical advantage in allowing a very wide range in numbers to be conveniently plotted. In reading the graph, it should be borne in mind that the point plotted is the logarithm of the actual number of pelts.

TABLE 2.—The percentage of Hudson's Bay Company posts reporting maximum numbers of fox pelts during the years of abundance. Peak year of abundance for Ontario, as shown in figure 2, is marked with an asterisk

YEAR OF MAXIMA	PERCENTAGE OF POSTS	YEAR OF MAXIMA	PERCENTAGE OF POSTS	YEAR OF MAXIMA	PERCENTAGE OF POSTS
1916	29%	*1926	50%	1934	12%
*1917	52%	1927	43%	1935	33%
1918	19%	1928	3%	*1936	30%
		1929	3%	1937	12%
				1938	12%

that a large proportion of the posts reached a maximum catch of foxes in years other than the peak years indicated in figure 2. In 1917 a scant majority of the posts (52%) reported maximal numbers; in 1926 just half the posts (50%) reached maxima; and in 1936 less than one-third of the posts (30%) reported a maximum catch of foxes. In fact, during the period 1916 to 1938, but 43% of the posts conformed to the years of maxima as shown in figure 2.

INTERVALS BETWEEN YEARS OF MAXIMUM NUMBERS

Compiling the fox catch as shown in figure 2 gives two definite intervals between points of greatest abundance, the first being nine years (1917 to 1926) and the second being ten years (1926 to 1936). However, when the actual elapsed time between peak catches was computed for individual posts, the period was found to vary from a minimum of seven years to a maximum of thirteen years. The number of such varying periods between peaks of abun-

TABLE 3.—Percentage of Hudson's Bay Company posts having intervals of different length between years of maximum numbers. Interval between peaks of abundance as shown by figure 2, is marked with an asterisk

INTERVAL BETWEEN FIRST AND SECOND PEAKS		INTERVAL BETWEEN SECOND AND THIRD PEAKS	
8 years	14%	7 years	4%
*9 years	24%	8 years	22%
10 years	43%	9 years	55%
11 years	14%	*10 years	7%
13 years	5%	11 years	7%
		12 years	4%

dance was counted and tabulated. The percentage of posts showing periods of different length was then calculated. The results are shown in table 3.

It may be seen from table 3 that a large proportion of the posts do not have the same intervals between peaks of abundance as shown in figure 2. The minimum interval between the first and second peaks reported by any post was eight years, the maximum interval was thirteen years; and 76% of the posts failed to agree with the nine-year interval shown in figure 2. The minimum interval between the second and third peaks reported by any post was seven years, the maximum interval was twelve years; and 93% of the posts failed to agree with the ten-year interval shown in figure 2. During the 23 years under review (1916 to 1938) only 17% of the posts conformed to the intervals indicated in figure 2.

YEARS OF MINIMUM NUMBERS

The period of minimum collection of fox pelts at any one post frequently extended over two or more years, and in preparing table 4 the first year of lowest numbers following the period of abundance was considered to be the year of minima.

During the first period, 36% of the posts, and during the second period, 63% of the posts did not agree with the year of minimum numbers shown in figure 2. Throughout the space of 23 years (1916–1938) slightly less than half the posts, 49%, conformed to the years of minima as shown in figure 2.

INTERVAL BETWEEN YEARS OF MINIMUM NUMBERS

The time between years of minima at individual posts varies from eight years to twelve years. The percentage of the posts having intervals of various lengths is shown in table 5.

TABLE 4.—Percentage of Hudson's Bay Company posts reporting minimum numbers of fox pelts during years of scarcity. Year of minima as shown by figure 2 is marked with an asterisk

FIRST PERIOD OF SCARCITY		SECOND PERIOD OF SCARCITY	
Year of minima	Percentage of posts	Year of minima	Percentage of posts
*1920	64%	1929	22%
1921	16%	1930	16%
1922	12%	*1931	37%
1923	4%	1932	22%
		1933	3%

TABLE 5.—Percentage of Hudson's Bay Company posts having intervals of different length between years of minimum numbers. Interval between years of minima as shown by figure 2 is marked with an asterisk

LENGTH OF INTERVAL	PERCENTAGE OF POSTS
8 years	8%
9 years	28%
10 years	12%
*11 years	32%
12 years	20%

Sixty-eight percent of the posts fail to agree with the interval between years of minima shown by figure 2.

PERIODICITY OF THE ONTARIO FOX POPULATION

It is evident that throughout the twenty-three years, 1916 to 1938, marked variation has existed among the Ontario posts of the Hudson's Bay Company as to the times of greatest abundance and of greatest scarcity and also as to the manner and rate at which the increase and decrease in numbers progressed.

The total annual number of fox pelts received by the Hudson's Bay Company from its Ontario posts from 1916 to 1938 is represented by the curve shown in figure 2, which appears to show a well-marked periodicity for the whole of Ontario during this period. However, as has been shown, this curve

fails to conform to the actual conditions within the province as represented by a majority of the trading posts.

This lack of conformity is due to the wide differences in the numbers of fox pelts collected at individual posts. The average annual collection of the highest yielding post was more than 25 times that of the lowest post. Seven high-yielding posts collected more than 55 percent of all fox pelts and a group of northern posts collected more than 80 percent of the total Ontario catch for the 23 years from 1916 to 1938. Peak years for Ontario foxes as recorded by the Company occur when a majority of these high yielding posts report high catches. The curve in figure 2 records this circumstance, which is not necessarily the condition of the Ontario fox population as a whole.

From these considerations, it appears that compilation of the annual catch of foxes reported by the Hudson's Bay Company's Ontario posts for this 23-year period has resulted in a generalization which is misleading as to the actual condition of the fox population within the province. The curve in figure 2 is of statistical and economic significance and suggests that a biological periodicity may exist; but the periodicity which it appears to demonstrate is an arithmetic periodicity and not necessarily an inherent biological periodicity of the Ontario red fox population.

YEARS OF MAXIMUM NUMBERS AS REGIONAL PHENOMENA

From table 2 it may be seen that the years of maxima occur during three periods and that a varying percentage of posts reported maximum collections in each of the years concerned. When the posts reporting maxima during each period were compared, it became apparent that, with few exceptions, posts reporting maxima in any one year occupied the same general area. Maps of the province for each period of abundance were then prepared, and the years of maxima for each post plotted. The first period is shown in figure 3, the second period in figure 4 and the third period in figure 5.

During the first period of abundance (figure 3) the 21 posts reached maxima during one or other of the years 1916–1917–1918 and fell into three territorial groups. Five western posts reached maxima first in 1916, ten eastern posts reached maxima next in 1917, and four northern posts reached maxima in 1918.

During the second period (figure 4) the 28 reporting posts reached maxima during one or other of the four years from 1926 to 1929 and fell into two territorial groups, a northern group of 14 posts and a southern group of 11 posts. The effect of the variation in the interval between years of maxima (see table 3) may be seen in the rearrangement of the three groups of posts present in the first period of abundance into two groups in the second period. The order of reaching maxima has also been altered in twelve of 21 posts, for example, the four northern posts which had reached maxima during the third year of the first period, reached maxima during the second period in the first and second years.

In the third period (figure 5) the 33 posts reached maxima during one or other of the five years from 1934 to 1938 and broke up into four territorial groups. The two large north and south groups of the second period were rearranged into smaller and somewhat mixed aggregations, through the continued variation of the intervals between years of maximum collections.

FIG. 3. Years in which maximum numbers of red foxes were traded at each of the Hudson's Bay Company's Ontario posts (1916–1918).

Ten of the posts did not fit into these territorial groupings, two in the first period, four in the second period, and four in the third period. The two first period exceptions, Temagami and Grassy Narrows, collected few foxes even in the peak years and the difference between the 1916 and 1917 collections is so small, twelve pelts and one pelt respectively, that these exceptions are of little significance.

Long Lake and Grassy Narrows, two of the four exceptions in the second period, have poorly marked peaks. The 1917 collection at Grassy Narrows

exceeded that of 1916 by only two pelts and the 1928 collection at Long Lake exceeded that of 1927 by only eight pelts. These two exceptions also have slight significance.

There were four exceptions during the third period and three of these, English River, Albany and Port Severn, were due to a local abundance of prey (Cross, mss.).

FIG. 4. Years in which maximum numbers of red foxes were traded at each of the Hudson's Bay Company's Ontario posts (1926–1929).

During the three periods of abundance between 1916 and 1938, there have been 82 maximum collections of fox pelts recorded by Ontario posts. Seventy-two, or 88%, of the maximum collections are from posts which, reporting maxima in the same year, were also associated in a territorial group. Of the ten exceptions, four may be dismissed as of slight significance and three others as due to a local abundance of prey. Three cases then remain as established exceptions, a divergence of less than 4%.

Accordingly it may be said that a definite geographic relationship does exist in Ontario between posts having their maximum collection of fox pelts in the same year. Posts reaching maxima in the same year occupy contiguous territory and periods of maximum abundance in the numbers of foxes in Ontario are regional phenomena and not province-wide, as the curve in figure 2 appeared to indicate.

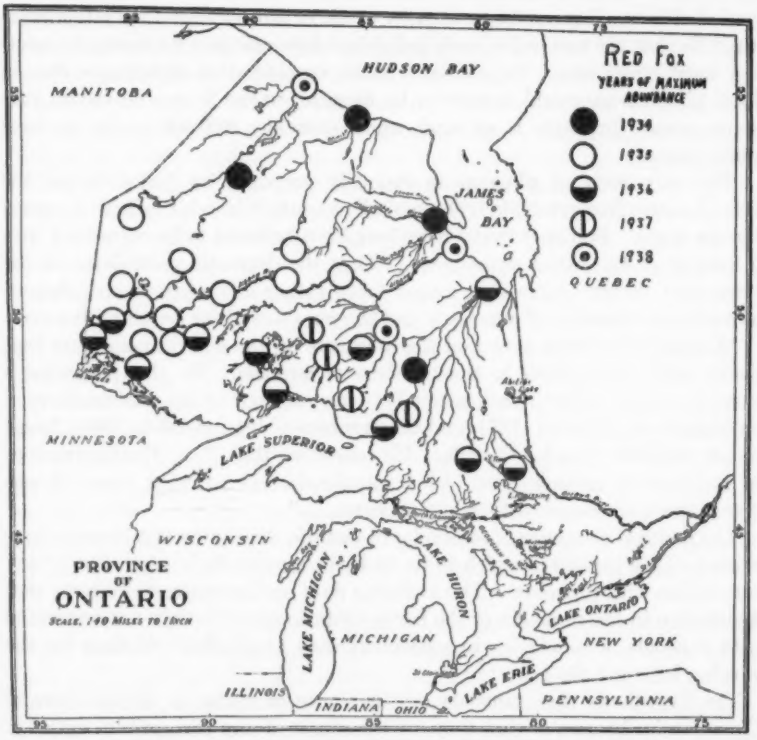

FIG. 5. Years in which maximum numbers of red foxes were traded at each of the Hudson's Bay Company's Ontario posts (1934–1938).

DISCUSSION

Zoologists have come to think of fluctuations in the numbers of mammals as something different from local changes in numbers. Implicit in most writings on mammal populations is the concept that true cyclic phenomena involve vast areas and that local or regional changes in numbers are not to be regarded as truly cyclic. "... truly cyclic phenomena are comparable to changes in the volume of water in a lake while the waves and ripples represent

more or less erratic changes in abundance in a particular species which must be prevented from obscuring the investigator's view of the truly cyclic phenomena. This calls for comparison over a considerable range of territory so that differences due to local phenomena may be eliminated. . . . " (Clements and Shelford, 1939, p. 188).

A species becomes abundant in an area when the birth rate exceeds the death rate during a sufficient number of breeding seasons. During such a period of increasing numbers, whether cyclic or not, more individuals survive than die; but the survival of each individual depends upon its success in meeting local conditions. To eliminate from consideration differences due to local phenomena would appear to be illogical, unless it can be shown that some general principle is at work which overrides differences due to local phenomena.

The only body of phenomena seriously proposed by biologists for the rôle of controlling principle is the periodic variation in solar radiation caused by sun spots. Sun spot cycles have long been believed to be correlated with a variety of terrestrial phenomena. Thus the dramatic possibilities of the "sun spot theory" have encouraged some rather adventurous speculations as to the relationship of sun spots and the numbers of fur-bearing mammals.

MacLulich, in 1936, reviewed the literature on the correlation of sun spot cycles with fluctuations in the numbers of animals. He also presented a careful analysis of the relationships between sun spot cycles, the numbers of varying hares (1786 to 1936), and the numbers of lynx (1750 to 1933), based on all available data for Canada. He concluded that, ". . . The fluctuations in numbers of neither lynx (*Lynx canadensis*) nor varying hares (*Lepus americanus*) are correlated with sun spots. . . ."

The regional character of fox cycles in Ontario during the last twenty-three years and the periods in which these cycles occur give little suggestion of any correlation with sunspots. The available data on the contrary suggests that fluctuation in the numbers of the fox in Ontario are definitely not correlated with sunspots, a conclusion in agreement with MacLulich's findings for the varying hare and the lynx.

The hypothesis that sunspots are the cause of cycles in the numbers of Canadian fur bearers or that they are the source of any perceptible control of such cycles must be regarded as an interesting speculation which the data now available does not support. Until some evidence for the existence of a coordinating principle is brought forward, any generalization as to cycles among Canadian fur bearers that ignores differences due to local phenomena can not be seriously regarded.

The best available data for the study of cycles in mammal populations and the only actual figures of mammal numbers over a long period of years are to be found in the Hudson's Bay Company's records of the fur trade. Seton (1911 and 1928) and Hewitt (1921), used the record of the Company's annual

sales of furs to demonstrate the existence of cycles in the numbers of Canadian fur-bearers. These writers did not define the territorial extent of the fur cycles but quite evidently thought of them as covering the entire area from which the furs were drawn. Hence, for many fur-bearers, the cycle has been assumed to be continent-wide in extent since the pelts sold were collected by the Company's trading posts and for the last hundred years these posts have been located not only on Hudson's Bay but throughout Canada from Atlantic to Pacific.

The reality of these fur cycles has been accepted without serious question by later investigators. Elton (1924) and MacLulich (1936) criticized certain details of the figures used by Seton and Hewitt but neither they nor later writers appear to have questioned the propriety of using figures compiled from such diverse and varying sources to demonstrate cyclic phenomena.

The fur sale figures used by Seton, Hewitt, and later writers include for any one year furs from all or nearly all of the Company's trading posts. Use of these figures to demonstrate cyclic phenomena is open to similar criticism, and to a greater degree owing to the vast extent of the area involved, to that presented in this paper regarding the use of the fox figures of the Ontario posts. Curves prepared from these fur sale figures may also be expected to fail to conform to the actual conditions in many localities throughout the Dominion.

As has been shown for Ontario, compiled figures of the annual fur yield may be accepted as suggesting that cycles occur among fur-bearing mammals. However, neither the Hudson's Bay Company's fur sale figures themselves nor the curves prepared from them can be accepted as representing the true periodicities of Canadian fur-bearers. It is probable that the cycles demonstrated by Seton and Hewitt and used by many later writers are in the main arithmetic periodicities and not inherent continent-wide biological periodicities of Canadian fur-bearers.

The concept of a Canadian fur cycle in the generally accepted sense of a sort of continent-wide biological tide is an intriguing speculation but on the basis of the evidence brought forward to date it must be regarded as "not proven." The data presently available for Canadian fur bearers agree with those presented by MacLulich (1937) for the varying hare in strongly suggesting that fluctuations in numbers are regional phenomena arising from changing local conditions. Generalizations regarding cyclic phenomena among Canadian fur bearing mammals must wait upon a clearer understanding of the significance of local variations in numbers.

LITERATURE CITED

CLEMENTS, F. E., and V. E. SHELFORD. 1939. Bio-ecology. John Wiley and Sons, Inc., New York.

ELTON, CHARLES S. 1924. Periodic fluctuations in the numbers of animals; their causes and effects. Brit. Jour. Exper. Biol., vol. 2, no. 1, pp. 119–163.

HEWITT, CHARLES GORDON. 1921. The conservation of the wild life of Canada. Chas. Scribner's Sons, New York.
MACLULICH, D. A. 1936. Sunspots and the abundance of animals. Jour. Royal Astronom. Soc. Canada, July–August, 1936, pp. 223–246.
——— 1937. Fluctuations in the numbers of the varying hare (*Lepus americanus*). Univ. of Toronto Studies, Biol. Ser. no. 43, 136 pp.
SETON, E. T., 1911. The Arctic Prairies. Chas. Scribner's Sons, New York, 415 pp.
——— 1928. Lives of Game Animals. 4 vols., Doubleday, Doran and Company, Garden City, New York.

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SHIFT OF POPULATION AMONG HIBERNATING BATS

BY G. EDGAR FOLK, JR.

The belief that the hibernation of warm-blooded animals is a continuous state of sleep or torpidity is now in general disrepute. There is much evidence which shows that hibernation is interrupted by periods of activity. Johnson (1931) studied the hibernation of the 13-lined ground squirrel and observed periods of waking and feeding. Observations on winter activity in hibernating bats have been made by Hahn (1908) in Indiana, Robin (1881), Rollinat and Trouessant (1895) in France, Swanson and Evans (1936) in Minnesota, and Guthrie (1933) in Missouri.

During the fall and winter of 1937–1938 a study of bats in hibernation in New York State was made to see if different conditions of climate produced different habits of hibernation from those found by the other workers. The cave selected for this study was the Indian Oven Cave in Ancram, near Millerton, New York, a few miles from the Tristate Corner of Massachusetts, Connecticut, and New York. The bats hibernating in this cave were almost entirely *Myotis lucifugus*, with occasional specimens of *Myotis keenii septentrionalis*, *Myotis sodalis*, and *Pipistrellus subflavus*.

From October 2 to March 6, fifteen trips were made to the cave. I wish to acknowledge the assistance of Mr. and Mrs. Emerson Quaile of the Salisbury School, and Mr. Monroe Stearns of Washington, D. C., for making these visits possible. Several students of the Salisbury School were particularly helpful in making observations and assisting in banding activities. Donald R. Griffin of Harvard University made many valuable suggestions and lent me the complete data of his banding work on New England bats.

The Indian Oven Cave is an extensive limestone fissure on top of a high ridge. It has two tall chambers, approximately 50 feet in height, connected by a series of small chambers. Over the floor of the cave runs a brook, disappearing as a waterfall in a low, wide chamber at the end of the cave. This last section is about 150 feet from the entrance. In the discussion to follow it will be called the end chamber. The cave was suited to the study in question

because most of its walls could be examined on each visit and because the bat population was small enough for reasonably accurate counting.

The physical environment of the cave interior was quite constant. The inside temperature dropped slowly in October and November and then remained about 40°F. the rest of the winter. (See Table 1 and Figure 1.) There was considerable fluctuation in the moisture in the cave, as indicated by the volume of flow of the brook, drip from the roof, and saturation of the air. At times the floor would be practically a torrent, there would be a constant drip from the roof, and water would have condensed on every object in the cave. At other times all parts of the cave would be practically dry.

TABLE I.—*Summary of winter observations in the Indian Oven Cave*

DATE	TOTAL NUMBER OF BATS COUNTED	NUMBER OF BATS IN END CHAMBER	TEMPERATURE (FAHRENHEIT)		
			In middle of cave	Entrance of cave	Outside cave
Oct. 1, 1937	5[2]		45°		
Oct. 9 "	30		45°		
Oct. 17 "	40		44°		64°
Oct. 24 "	32		46°		41°
Oct. 31 "	48		46°	48°	39°
Nov. 5 "	46		45.5°	46.4°	45°
Nov. 14 "	45		46.5°	48.2°	49°
Nov. 20 "	60		42.8°	44.6°	30°
Dec. 5 "	87		43.7°	44.6°	35°
Dec. 11 "	98	30	39.2°	43.7°	20.3°
Jan. 8, 1938	175	114	41°		25°
Jan. 20 "	147	65	36.5°		25°
Feb. 6 "	200[1]	72	39.2°		44°
Feb. 24 "	52	15	41°		32°
Mar. 6 "	81	30	38.3°		28°

[1] On this date 200 bats were observed by usual census methods, but about 13 more were discovered in a hidden chamber.

[2] Only part of cave visited; more bats probably present.

Hahn (1908, p. 144) stated that there is no evidence that the bats he studied made any choice between wet and dry portions of the caves, in selecting hibernating positions. In Indian Oven Cave some bats observed were perfectly dry one week and laden with moisture the next, an indication that selection of hibernating place to avoid moisture would be useless.

There were no appreciable air currents in the cave and temperature records show that the mixture of air between parts of the cave was slow. These facts would remove any possibility that bats in the cave could be aware of external temperature changes without going beyond the entrance.

On each visit to the cave most of its surface was searched for bats. On the first trip, October 1, only a portion of the cave was searched; there were

undoubtedly more bats present than were recorded. On February 6, all bats in the cave were collected and banded, or if they had been previously banded, they were recorded as having returned to the cave. At this time it was discovered that a small upper chamber could not be observed from any point on the floor. In this chamber only 10 to 15 bats were taken. All other portions of the cave were easily examined from the floor. Therefore the census for each trip was relatively correct. The walls of the cave were exceptionally smooth, with the result that no more than five bats in the entire winter were found in crevices or fissures.

An attempt was made to observe the habits of individual bats, as well as to determine changes in number of the total population. We encircled some individuals with yellow chalk lines; but better results were obtained by plotting on a diagram exact positions of dormant bats.

Time of start of hibernation.—No record of observations on the start of the hibernation period could be found for New England. In Iowa, Sherman (1929) wrote that over a period of years the latest disappearance date for the bats of her summer colony was October 16, and the earliest was September 19. Hahn (1908, p. 148) records finding two *Pipistrellus subflavus* hibernating on September 5 in the cave he was studying in Indiana. He also saw bats flying at a distance from their dwelling place on November 8, at Washington, D. C. Guthrie (1933, p. 17) wrote that in Missouri few *Myotis lucifugus* are present during October and that *Pipistrellus* enters the caves in the middle of October.

In the Ancram (New York) cave five torpid bats (*M. lucifugus*) were found on October 1, 1937, only a portion of the cave being examined. On October 4 in the nearby Twin-Lakes Cave in Salisbury, Connecticut, four *M. lucifugus* were found hibernating. An observation on late seasonal activity was made near this same cave in Salisbury on November 2. Two bats, probably *M. lucifugus*, were seen hunting in the rain over the surface of a lake. It was still very light (4:45 p.m.) and the temperature was 55°F.

Activity during the hibernation period.—Mention has already been made of several workers who witnessed activity during the hibernating period. From her observations on the Rocheport Cave (Missouri), Guthrie (1933) recorded that *Myotis sodalis* is not a true hibernator in that region, so apparent were the changes in the population of this species following breaks in winter temperatures. Concerning *Myotis lucifugus* she found that they are quite torpid until mid-January, but that during warm February weather their population increases in the cave.

In the New York cave an increase in population occurred in midwinter, although no increase in the number of active bats had been noted during visits to the cave in December (see table 1). It might be expected that there would be a few active bats encountered each trip, but this was not the case. No

bats were seen flying in the cave until November 5. On this date several were active and there had been pronounced shifting of positions among previously noted individuals. This activity may have been due to two weeks of reasonably mild weather, with a maximum of 65°F. and a minimum of 49° on October 27. No activity had been observed, however, on October 31.

From November 5 to February 6 no bats were seen flying in the cave. On February 6 all except a few of the bats were captured. Up to this time every effort had been made to disturb the bats as little as possible. Loud noise and talk was avoided, the only factor of disturbance being the lights, to which bats occasionally responded by raising their heads and chittering.

During the two trips after the entire population was collected (February 6), the small number of bats that remained were generally restless, many of them flying about. This activity may have been assisted by the disturbance on February 6, but may also have been an example of the late winter activity pointed out by Hahn. He found that the bats he studied were least active in autumn and early winter, and most active during cold weather of late winter.

Daily rhythm of activity.—In the Indian Oven Cave no flying bats were observed from November 5 to February 6 and few of the dormant bats showed signs of life when illuminated. These facts may be explained by the work of Griffin and Welsh (1937). Bats collected by them from New England caves were kept in constant darkness and a record made of their activity. The process of feeding interfered with the records, and one bat learned to anticipate the time of feeding. Still it was apparent that the bats of New England have a pronounced diurnal rhythm; they continue to be active (under constant conditions) at the same hours when they would normally be feeding. Guthrie (1933) suggests that bats are aroused periodically from hibernation by thirst. If any vestige of a diurnal rhythm penetrates the stupor of hibernation, it would be natural that the time of awaking and brief activity in the cave would coincide with the normal rhythm of night activity. Observations of the Indian Oven Cave in winter during the night might show more activity than daytime visits.

A few observations relating to the question were made on twenty-five *Eptesicus fuscus* that I kept from January to June in hibernation in a cold room which varied from 40° to 42°F. These bats were in a very dormant state during the daytime, but if the cluster was examined at night, there would always be some individuals awake and active.

Effect of temperature on hibernating bats.—A comparison of the temperatures of the caves studied by other workers shows that the Indian Oven Cave had a lower constant temperature than any other, except the East Dorset, Vermont cave. Where a range of temperatures is given, the records are for different parts of the caves on the same date. Added to the records for these

caves is one for a mine in Roxbury, Connecticut. The Missouri cave and the Connecticut mine had significant currents of air flowing through them.

Mitchell, Indiana (Hahn)	Sept., 57° F.	Jan., 51° F.
St. Peter, Minnesota (Swanson and Evans)		
Cave one	Feb. 12, 45°–48° F.	Mar. 25, 45°–48° F.
Cave two	Feb. 12, 42° F.	Mar. 25, 44° F.
Boone County, Missouri (Guthrie)	Dec. 26, 49°–54° F.	Feb. 20, 41°–54° F.
Roxbury, Connecticut (Folk)	Nov. 11, 37°–59° F.	
Ancram, New York (Folk)	Oct. 31, 46°–48° F.	Dec. 11, 39°–44° F.
East Dorset, Vermont (Griffin)	Nov. 11, 38° F.	Feb. 27, 30°–39° F.
Chittenden, Vermont (Griffin)	Nov. 3, 48°–50° F.	Nov. 10, 43°, Mar. 3, 42°
Plymouth, Vermont (Griffin)	Nov. 12, 46.4° F.	
Chittenden, Vermont (Griffin)	Feb. 22, 30°–31° F.	

[The temperature on February 22 was taken in the small south chamber. The outside temperature was 16°F., and there were 75 bats in the chamber at this time.]

Of these caves those in New England are the coldest. It is interesting that observations in Ancram, New York, were similar to those in the comparatively warm cave in Mitchell, Indiana.

Concerning the influence of temperature on winter activity there seems to be some disagreement. When the period of hibernation is near termination, Hahn (1908, p. 150) considered the response to temperature a simple process of the bats' testing the air at the cave entrance. If the air is found to be warm enough, an excursion is made in search of food. If the weather becomes uncomfortably cold the bats return to the cave.

Guthrie (1933, p. 16) discovered that the numbers of *Myotis sodalis* in the Rocheport Cave in Missouri increased after an unusually warm week in December, while after a warm night in January, many *M. sodalis* left the cave. Numbers of *M. lucifugus* increased on several dates in February, once after an unusually warm day with a maximum of 77° and a minimum of 63°.

Figure 1 shows the bat population in the Indian Oven Cave on different dates plotted against maximum and minimum temperatures. The outside temperatures were compiled from the record of the Cream Hill, Connecticut station in the monthly meteorological summaries of the U. S. Department of Agriculture. This station is about 10 miles from Ancram.

Following the suggestions of Hahn and Guthrie, we may assume that prior to about January 1 bats in the vicinity of Ancram were active outdoors or were sleeping in places unsuited for hibernation. The reasonably warm weather around November 28 and December 4 made it unnecessary for them to retreat to the shelter of caves. The sub-zero period around December 13 was undoubtedly the influence which started an increase in numbers in the cave. We may consider that this weather indicated to bats outside the cave the unsuitability of their hibernating or resting places. It is likely that the periods of higher temperatures around December 17 and 22 were the times

when the actual migration was made. This hypothesis is supported by the fact that sub-zero weather around January 18 and January 28, both followed by periods of comparatively high temperatures, preceded another increase in bat population.

Feeding during hibernation.—Related to the problem of activity during hibernation is that of food. Hahn (1908, p. 140) made the statement that bats come out in mild weather during the winter to secure food; later (p. 147) he said that they do not obtain food during the winter. His real contention seems to be that they live during the winter on stored fat. He did not believe

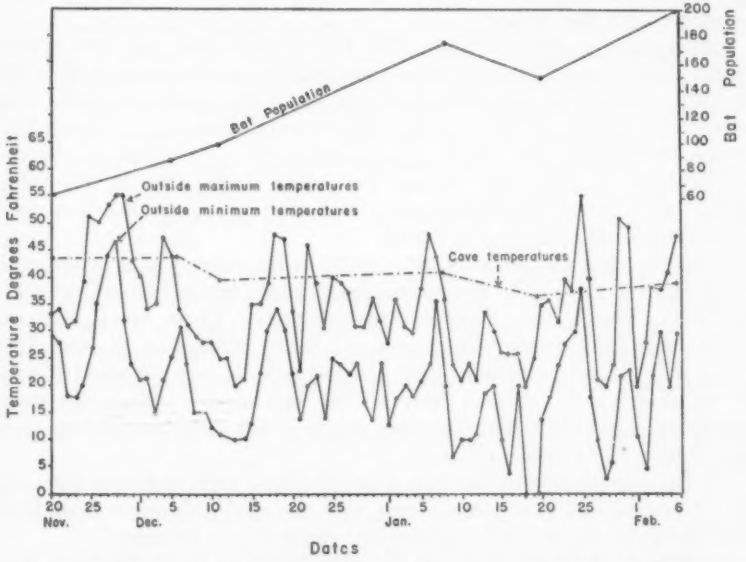

FIG. 1. Graph showing relation of outside and cave temperatures to the bat population in the Indian Oven Cave, from November, 1937 to February, 1938.

that fecal matter present in animals killed in winter indicates that they had eaten during the winter. Guthrie (1933, p. 10) found fecal matter containing insect remains in *M. lucifugus* on December 3, 1931, but no other indication of feeding until the discovery of insect remains in the feces of *M. grisescens* on April 30. Swanson and Evans (1936, p. 40) found that the caves in Minnesota supported an abundant insect population and that the bats collected dropped well-formed feces.

In the New York cave there was little evidence that the bats fed while in the cave. A large group of bats collected there on February 6 dropped relatively few feces; and the evidence of Hahn indicates that these feces were not necessarily the result of winter feeding. The only insects apparent in

or around the cave during the winter were a few cave crickets (*Ceutophilus*), gnats, and for a brief period, many snow-fleas (*Collembola*).

Several observers of bats in hibernation have wondered how bats drink during the winter. This process was observed when the population of this cave was collected for banding. Bats which had been previously banded were recorded and released, but it was necessary to bring the rest of the population back to a heated room to do the banding. They were kept in a cool room all night and returned to the cave the next day, but the rise in temperature and activity made them very thirsty, for when they were released in the cave most of them immediately started lapping the drops of moisture condensed on the wall.

Observations on individual bats.—On April 5, 1937, 332 bats were banded in the Indian Oven Cave. Of these same bats 95 were taken again February 6, 1938. Eleven of these were captured again November 11, 1938. This means that 11 bats, at least, in spite of noise and disturbance, had come back to the Indian Oven Cave three years in succession. Six of the bats banded on February 6, 1938, were retaken on November 11, 1938 in the Indian Oven Cave. These few at least were unaffected by being taken to a warm room during their hibernating period.

Some evidence was found of bats' spending the entire winter in the cave. On October 9, 1937, eight *Myotis lucifugus*, banded in the Indian Oven Cave the winter before, were found hibernating there. These, along with two other unbanded animals, were examined. When replaced on the wall, they clung with difficulty; for when their grasping reflex is once disturbed it seems to function poorly. A week later all ten had moved. When the entire population was collected on February 6, five of the eight banded bats mentioned were still present.

On October 24, several bunches of *M. lucifugus*, each including from five to eight individuals in complete torpor, were encircled with yellow chalk lines. On October 31 all the marked groups had changed their positions.

On November 5 it could be seen that there had been much shifting of positions of hibernating places, with no apparent change in numbers of bats. On November 14 this was even more apparent. Many bats were in new positions but there was no increase in total number. Starting on October 31, one group of bats was watched for four weeks in succession. The first week it was composed of three individuals, the second of five, the third of eight, and the fourth of three.

Further evidence of activity within the cave is seen in a comparison of data obtained on the four trips December 11–February 6. The following percentages of the entire population were found in the small end chamber:

December 11, 30.6% of entire population
January 8, 65.1% of entire population
January 20, 44.2% of entire population
February 6, 36.9% of entire population

It would seem from this evidence that the normal state of bats hibernating in this New York cave is never one of complete lethargy.

There is some evidence to show, as is brought out by Hahn and others, that the degree and duration of torpidity in some cases is greater than normal. On January 8 the accumulation of observations showed that six or eight bats had definitely not moved for over one month, some of them having remained throughout this period in groups of two.

On October 17 a bat (*Myotis lucifugus*) was observed approximately 15 feet from the entrance, practically in daylight. This specimen always awoke easily and was constantly covered with beads of moisture. He remained in this position until after November 5. It is unlikely that his change of position was caused by a cold snap following this date, because temperatures taken beside him on two occasions and in the same place during several later trips showed that there was little mixture of air in parts of the cave and that this portion remained warmer for some time than the main chamber.

Another bat (*M. lucifugus*) was observed near the entrance on November 28. He remained in this position for two months after this time, always covered with moisture and sometimes awaking and lifting his head when disturbed by flash-light.

The longest record of inactivity was that of a single isolated *M. lucifugus* near the entrance of the end chamber. It was first observed on October 9. Up to the time of banding on February 6, it had made no move and shown no sign of being awakened by flashlights. Although left undisturbed at the time of collection, it had moved the next day. This bat had remained inactive for 120 days.

Spring observations could not be made after March 6. The decrease in population February 24 and March 6 cannot be interpreted as an indication of spring migration because of the disturbance of banding operations on February 6. When the cave was examined on June 11 the following year (1939), the only bats it contained were three male *Pipistrellus subflavus*.

Hahn (1908) recorded a few observations on individual bats in the cave in Mitchell, Indiana. Of 18 bats observed there between November 19 and December 3, 14 had moved within one week and none remained in the same place during two weeks. One bat remained stationary near the entrance from February 4 to February 27, although it was reached by daylight. During several days at a time it experienced freezing temperature.

Summary of observations on individual bats.—The above information, gathered from observations and banding evidence, adds the following facts to knowledge of the natural history of bats:

A number of bats returned to the Indian Oven Cave three years in succession, and some taken there in February, 1938, were retaken in the cave in November, 1938. Several bats were taken in the cave in October and again four months later in February. Although bats in this cave normally awoke

for periodic activity, occasional individuals remained dormant for three and four months.

Evidence of winter activity in other caves.—Griffin (1940) provided evidence of shift of population among hibernating bats from the records of his banding work. In a cave at East Dorset, Vermont, which has such a large entrance that it seems to become too cold for hibernating in midwinter, as many as 400 to 800 bats may be found in November. In early April there are never more than fifty. Furthermore, Griffin records three cases in which bats moved from one cave to another during the winter.

The seasonal totals for bats banded by Griffin in caves at Chittenden, Vermont, Chester, Massachusetts, and Roxbury, Connecticut show that as a rule the populations increase considerably after November, although there is no evidence as to whether the additions come early or in midwinter. Only the data from caves visited during the fall, winter, and spring are given.

	Myotis lucifugus	*Myotis sodalis*
Chittenden, Vermont		
November 10, 1934	9	126
February 22, 1935	71[1]	168[1]
April 3, 1935	65	73
Chester, Massachusetts		
November 29, 1936	165[1]	60[1]
February 20, 1937	503	9
May 1, 1937	265	2
Roxbury, Connecticut		
November 22, 1936	148[1]	224[1]
January 22, 1937	146	8
April 7, 1937	182	—

[1] These figures do not represent total population, since a large number of bats were not captured or recorded.

The fall insemination problem.—The application of the information in this paper to the question of whether autumnal insemination in bats functions in spring fertilization is interesting. Hartman (1933) has collected evidence of other workers to show that both winter and spring inseminations actually occur. The present paper shows that bats in some, and probably all, New England caves, are active enough throughout the winter to allow mating to take place.

SUMMARY

(1) Data are given concerning date of start of hibernation of bats, annual return of bats to hibernating places, and winter temperatures of hibernating places.

(2) There is a shift of population of New England bats during the winter from other places of temporary rest to final place of hibernation.

(3) The normal state of bats hibernating in this cave is one of periodic activity within the cave. Occasional individuals remain dormant for three and four months.

(4) It is probable that most hibernating bats occasionally awaken at night.

(5) Bats in the Indian Oven Cave, Ancram, New York, probably do not feed throughout the winter; but some were observed to drink by lapping moisture from the cave walls.

LITERATURE CITED

GRIFFIN, D. R. 1940. The migrations of New England bats. Bull. Mus. Comp. Zool., vol. 86, no. 6, pp. 217–246.

——— and J. H. WELSH. 1937. Activity rhythms in bats under constant external conditions. Jour. Mamm., vol. 18, pp. 337–342.

GUTHRIE, M. J. 1933. Seasonal movements and habits of cave bats. Jour. Mamm., vol. 14, pp. 1–19.

——— 1933. The reproductive cycles of some cave bats. Jour. Mamm., vol. 14, pp. 199–216.

HAHN, W. L. 1908. Habits and sensory adaptations of cave bats. Biol. Bull., vol. 15, pp. 135–193.

HARTMAN, C. G. 1933. On the survival of spermatozoa in the female genital tract of the bat. Quart. Rev. Biol., vol. 8, pp. 185–193.

JOHNSON, G. E. 1931. Hibernation in mammals. Quart. Rev. Biol., vol. 6, pp. 439–461.

ROBIN, H. A. 1881. Recherches anatomique sur les mammifères de l'ordre des Chéiroptères. Thèse Fac. des Sci., Paris. Also: Ann. des Sci. Nat., Zool., vol. 12, no. 2, pp. 1–180.

ROLLINAT, R., and E. TROUESSART. 1895. Sur la reproduction des chauves-souris. Bull. Soc. Zool. France, Proc. Session Jan. 22; vol. 20, pp. 25–28.

SHERMAN, A. R. 1929. Summer outings of bats during fourteen seasons. Jour. Mamm., vol. 10, pp. 319–326.

SWANSON, G. and EVANS, C. 1936. The hibernation of certain bats in southern Minnesota. Jour. Mamm., vol. 17, pp. 39–43.

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THE TECHNICAL NAME OF THE ALLEGHENY WOODRAT

By Earl L. Poole

Our knowledge of the Allegheny woodrat has had a curious history. The animal was known as early as 1749, when Peter Kalm, in his "Travels in North America," wrote, pp. 47–48:

"Mr. Bartram maintained that before the Europeans settled here, rats had been in the country; for he saw a great number of them on the high mountains which are commonly called the Blue Mountains [probably of Berks and Schuylkill counties, Pennsylvania], where they live among stones and in the subterraneous grottoes which are found there." Forty years later Pennant (1788, pp. 150–151) erroneously imagined that Kalm's account referred to the black rat. Nevertheless, he wrote: "By Mr. Bartram's observations it appears very certain that these animals are natives of America. They are found even at present in the most desolate places, as well as in the houses and barns of the inhabited parts."

Nothing further was heard of the Allegheny woodrat until Baird (1857, p. 498) described *Neotoma magister* from skull fragments found in caves in Pennsylvania, one of them situated in the neighborhood of Carlisle, Cumberland County, the other near Harrisburg, Dauphin County. These remains evidently belong either to the very late Pleistocene or to the Recent period (Hay, 1923, pp. 320–321; Miller, Jour. Mamm., this number, pp. 319–321).

Baird was ignorant of the fact that living *Neotoma* exists in Pennsylvania. He, therefore, naturally regarded the animal whose bones were found in the caves as extinct. Not until 1893 was the occurrence of living Pennsylvanian woodrats made known. In that year Stone (1893, p. 16) described as a new species, *Neotoma pennsylvanica*, two female woodrats sent to him by J. G. Dillin from the vicinity of Pine Grove, Cumberland County, Pennsylvania, only about 20 miles southwest of Carlisle (Rhoads, 1894, p. 213).

For some time subsequently a discussion was waged as to the relationship of the supposed extinct *Neotoma magister* and the living *N. pennsylvanica*. In 1894 Samuel N. Rhoads regarded the animals as identical. Therefore he placed the name *pennsylvanica* in the synonymy of *magister*. Later (1903, p. 92), in reviewing this controversy, he reluctantly agreed with Gerrit S. Miller, Jr. (1899, p. 318) in accepting the opinion of Dr. E. A. Mearns (1898, p. 334) that the two were distinct. Mearns believed that: "*Neotoma magister* proves to have been a considerably larger and stouter animal than *N. pennsylvanica*, the skull is relatively shorter . . . the mandibles are deeper . . . the tooth row broader and longer." Edward A. Goldman, in his "Revision of the Wood Rats of the Genus Neotoma" (1910, p. 83) wrote: "Comparison of this [i.e. Baird's] rather scanty material with a considerable number of fully adult as well as immature specimens of the living species inhabiting the same region shows very close relationship. The differences noted, however,

appear to be constant, and in the absence of material establishing their identity both [animals] should receive specific recognition."

Still more recently I have had an opportunity to examine the type material in the U. S. National Museum and to compare it with additional specimens from Hartman's and Durham caves in the collection of the Philadelphia Academy of Natural Sciences and with recent specimens from eastern Pennsylvania. Since the deposits in both Hartman's and Durham caves were regarded by Hay (1923, pp. 308, 311) as belonging to "the latest times of the Wisconsin stage, or even the recent," it is difficult to understand why this very important lot of material, though labeled "*magister*", was not previously used for comparison.

A fact of great importance in this connection is the absence of woodrat remains from the Port Kennedy deposits, considered by Hay to "represent a time about equivalent to the Aftonian interglacial stage," and from the Frankstown Cave, which furnished many fossils of about Middle Pleistocene time (Hay, 1923, pp. 321–322). This rat, therefore, almost certainly came into Pennsylvania at some later period. Remains of *Neotoma magister* found in Cumberland Cave, Cumberland, Maryland, were considered of mid-Pleistocene age by Gidley and Gazin (1938, pp. 59–60).

That *Neotoma magister* once had a much more extensive range than at present in Pennsylvania is shown by the fact that abundant remains have been found associated with the earlier Indian cultures in rock shelters near Reading, Pennsylvania, at a considerable distance from the animal's present haunts. Its bones occur also in the previously mentioned Durham and Hartman's caves, and in caves in Lancaster County, where it certainly does not occur at present.

The frequent presence of woodrat remains in Indian rock-shelter sites is of considerable interest. In every such site in the neighborhood of Reading in which I have excavated I have found numerous mandibles scattered among the vestiges of aboriginal occupation. In the Poplar Neck site, in particular, woodrat jaws occurred from near the surface down to a depth of 48 inches, where they were associated with artifacts of an early coastal Algonkian culture that must have existed well over two thousand years ago.

All of the available newer material was compared with Baird's *magister* cotypes. No peculiarities could be found that would justify the recognition of two species.

The six more important measurements leading to this conclusion can be summarized as follows: (1) Distance from condyle to alveolus of incisor, *magister* (2 adults), 30.9–32.5, "*pennsylvanica*" (7 adults), 31.0–32.8; (2) distance from concavity between condyle and angular process to alveolus of incisor, *magister* (1), 29.6, "*pennsylvanica*" (7), 28.5–29.5; (3) diastema, *magister* (4), 8.6–10.0, "*pennsylvanica*" (7), 8.6–10.0; (4) least depth of mandible through diastema, *magister* (4), 5.2–5.85, "*pennsylvanica*" (7), 5.2–6.1;

(5) depth of mandible at front of first molar, *magister* (4), 7.8–8.5, *"pennsylvanica"* (7), 7.9–9.0; (6) length of lower molar series, *magister* (5), 9.6–10.0, *"pennsylvanica"* (7), 9.3–10.1.

These figures clearly show that all the dimensions of *magister* can be duplicated or exceeded in the series of recent specimens of *pennsylvanica* trapped in the Blue Mountains of northern Berks County and other nearby localities. Large and fully adult specimens are, however, rarely taken.

On the other hand, when the skull of *Neotoma pennsylvanica* is compared with that of any of the other larger species of *Neotoma*, such as *N. floridana*, *N. cinerea*, or *N. fuscipes*, for instance, the dimensional differences are so marked that there is no possibility of confusion.

It seems obvious from the evidence now at hand that the older name *Neotoma magister* Baird must take the place of *Neotoma pennsylvanica* Stone as the correct designation of the Pennsylvania woodrat.

LITERATURE CITED

Baird, S. F. 1857. Mammals of North America, p. 498.

Benson, Adolph B. 1937. Peter Kalm's Travels in North America, pp. 234–235.

Gidley, James W. and Gazin, C. Lewis. The Pleistocene vertebrate fauna from Cumberland Cave, Maryland. Bull. U. S. Nat. Mus., 171, pp. 54–60. May 5, 1933.

Goldman, Edward A. 1910. Revision of the wood rats of the genus Neotoma. North Amer. Fauna no. 31, pp. 82–86.

Hay, Oliver P. 1923. The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°. Carnegie Inst., Publ. no. 322, pp. 308, 311.

Holland, W. J. 1908. Ann. Carnegie Mus., vol. 4, pp. 228–233.

Kalm, Peter. 1771. Travels in North America, pp. 47–48.

Mearns, Edgar A. 1898. Notes on the mammals of the Catskill Mountains, New York, with general remarks on the fauna and flora of the region. Proc. U. S. Nat. Mus., vol. 21, pp. 334–335.

Miller, Gerrit S., Jr. 1899. Preliminary list of New York mammals. Bull. New York State Mus., vol. 6, no. 29, p. 318.

Pennant, Thomas. 1788. Arctic Zoology, pp. 150–151.

Rhoads, Samuel N. 1894 A contribution to the life history of the Allegheny Cave Rat, Neotoma magister Baird. Proc. Acad. Nat. Sci. Philadelphia, pp. 213–221.

——— 1903. The Mammals of Pennsylvania and New Jersey, pp. 85–92.

Stone, Witmer. 1893. Description of a new species of Neotoma from Pennsylvania. Proc. Acad. Nat. Sci. Philadelphia, pp. 16–18.

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BONES OF MAMMALS COLLECTED BY BAIRD IN PENNSYLVANIAN CAVES

By Gerrit S. Miller, Jr.

Before he moved to Washington, in November, 1850, to take up his duties as Assistant Secretary of the Smithsonian Institution, Professor Spencer F. Baird had unearthed many bones, mostly mammalian, from the floor material of caves near his home at Carlisle, Cumberland County, southern Pennsylvania. These specimens he afterward brought to Washington, where they became part of the nucleus of the present National Museum collection. Together with stone implements found in the same caves, they were formally accessioned in 1869 (Accession no. 1664: "Bones and stone implements from caves near Carlisle").

In August, 1849, Baird gave (at Cambridge, Massachusetts) a general account of the Carlisle caves, apparently the only one that he ever published, at the second meeting of the American Association for the Advancement of Science (1850, pp. 352–355). The more interesting parts of his paper are as follows:

"The main cave is on the bank of the creek, nearly on a level with the water, the entrance being ten feet high. The floor of the cave is nearly on a level with the extremity, and the cave is nearly three hundred feet in length. Here I obtained some of my specimens, which were generally imbedded in the floor of the cave.

"In addition to this locality there is another where the most perfect specimens were obtained. There is a series of galleries near the roof of this cave, which can only be reached by ladders. . . . These [galleries] are filled with mud, and in this mud the bones are distributed. The remains have evidently come in from above, as there is no other possible means by which they could have been filled to this height. The character of these remains is quite interesting in some respects. The number of species of mammalia found there is nearly twice that of present existing species in Pennsylvania. Nearly five per cent consist of extinct species; the remaining ninety-five per cent are recent. The recent bones are of various species of wolves, foxes, rabbits, bears, muskrats, otters, lynxes, panthers, beavers etc."

Of the two smaller caves (p. 253), one "exhibited an entrance on the top of a hill. . . ." The other "is on the bank of the Susquehannah, about half a mile below the railroad bridge. . . ." The bone deposits that they contained were, apparently, not very important.

In order to determine the probable age of the fauna represented by this cave material I have recently examined all of Baird's mammal bones now in the National Museum (Divisions of Mammals and of Archeology). They are abundant enough to give a good idea of the fauna existing in southern Pennsylvania at the time when the deposits were made. That this fauna

was entirely "recent" will be shown by the following enumeration of the 18 species that composed it.

Procyon lotor (Linnaeus).—Twenty-eight specimens representing 4 fragments of maxillae (3 retaining some of their teeth), 4 half mandibles, 7 loose teeth, 3 ribs, 1 innominate, 1 humerus, 8 ulnae, 1 fibula.

Lutra canadensis (Schreber).—Fragment of palate with pm^4 (rt.), 2 imperfect half mandibles (rt.), one (No. 15319) with pms 1–4, the other toothless.

Mephitis mephitis nigra (Peale and Beauvois).—Fifty specimens as follows, 3 skulls (Nos. 267535–537) in fresher and better condition than most of the cave bones; 9 half mandibles (4 rt., 5. l.) 1 from Ritner's cave; 1 left half of palate with all teeth but i^1; 36 miscellaneous bones and 1 left lower canine entered under No. 267538. Nothing unusual about any of these specimens.

Urocyon cinereoargenteus (Schreber).—Twenty-six specimens, including 7 fragments of skulls (representing at least 4 individuals), 4 mandibular halves (apparently 4 individuals), 5 loose teeth, 2 humeri, 2 radii, 1 ulna, 5 toe bones.

I find no remains of red fox among the cave bones. The specimens of *Vulpes* that Baird brought from Carlisle were all recently killed animals.

Canis sp.—Three specimens: (1) left radius, (2) distal two-thirds of right metacarpal, and (3) fragment of palate with pm^4 and m^1. The radius came from a domestic dog about the size of a coach-dog or a small collie (length, 148.2, distal width 24.2). The metacarpal closely resembles the corresponding bone of wolf no. 1308 (Fort Kearney, Nebraska) and of Russian wolf hound no. 269321. The teeth are not very different from those of Adirondack wolf no. 1804, except that the transverse diameter of the molar crown is only 18.5 mm. instead of 21 mm. They more nearly resemble those of collie no. 241137 (transverse diameter of molar 18.8). Their positive identification seems to be impossible.

Felis concolor couguar Kerr.—Left lower canine split longitudinally from base to tip, its length (chord) 48.2 mm; left femur (proximal 165 mm), much rodent-gnawed; shaft broken very obliquely as if by Indians; right tibia, proximal end broken off bluntly; in same condition as femur.

Lynx rufus (Schreber).—Four maxillary fragments with teeth representing, among them, the entire set from canine to molar; two right mandibular halves, one almost perfect, the other broken at middle of carnassial alveolus. There are also two mandibular halves (opposites but not mates; nos. 15326 and 15333) from a cave near Harrisburg. Taken as a whole these bobcat remains do not differ from the corresponding parts of present day animals, though some of the teeth are of maximum size (upper carnassial of No. 15322; length, 15.0; anterior breadth, 7.2; greatest height above alveolus, 9.6).

Homo sapiens Linnaeus (probably aboriginal).—A cervical vertebra (no. 6?) much distorted by arthritis. Doctor Hrdlička identifies it as "that of a small female."

Marmota monax (Linnaeus).—Half mandibles, 10 (6 right, 4 left); loose incisors, upper, 9, lower, 3. With two exceptions (Nos. 86880 and 86882) these jaws appear to be less ancient than the average of the cave bones. There are no marks of rodent gnawing on any of them. Neither Mr. A. H. Howell nor I can see any peculiarities to distinguish them from freshly collected specimens. They are labeled, in Baird's handwriting: "Fossil Arctomys Carlisle Cave."

Sciurus carolinensis subsp.—Right half mandible (no teeth except broken incisor). Labeled "squirrel lower jaw" in Baird's handwriting.

Castor canadensis Kuhl.—Imperfect mandibles (opposites), the left with m_1 and m_2 in place; 5 loose cheekteeth; right humerus, femur, and tibia, all immature, and all

except the tibia rather fresh in appearance. No rodent tooth marks; but the humerus bears scratches of a kind that could be made with a flint flake or a knife blade.

Peromyscus leucopus Rafinesque.—Right half of mandible with full set of teeth.

Neotoma magister Baird.—The cave rat material was catalogued October 24, 1872, under the museum numbers 12206–14. All of these specimens are now in the collection except no. 12210. They consist of 7 imperfect half mandibles (4 right, 3 left) and 1 left premaxillary fragment, all with incisors in place; all the jaws except nos. 12207 and 12213 carry at least two molars. When compared with the recently collected specimens of the Allegheny woodrat now in the National Museum the jaws from the Carlisle Caves are at once seen to have no peculiarities. Mr. Poole's conclusion (this number of the Journal of Mammalogy, p. 318) that Rhoads was right when he proposed (1894) to substitute the earlier name *Neotoma magister* Baird 1857 for the later name *Neotoma pennsylvanica* Stone 1893 is fully justified.

Ondatra zibethicus Linnaeus.—Right mandible with m_1 and m_2; femora, 1 right and 2 left. No rodent tooth marks. All except the right femur are rather fresh looking.

Sylvilagus floridanus mallurus (Thomas).—Twenty miscellaneous bones including right half of palate, 3 mandibular halves (1 right, 2 left), sacrum, innominate (left), femur (left), tibiae, 5; also 9 loose teeth. No rodent marks. Appearance rather fresh.

Cervus canadensis Erxleben.—Seventeen specimens as follows, 2 maxillary fragments numbered 199723, right with moderately worn anterior premolar, left with unworn m^3 and m^3; 5 loose teeth (i, rt., m^1 rt., m^3 l., m_1 l., m_3 rt.) numbered 269721; humerus (left) distal end numbered 269721; radius (left) distal end numbered 267551; navicular (right) numbered 267551; calcaneus (right) numbered 269721; distal end of 8th or 9th rib (left) numbered 267551; fragment of rib (108 x 35 mm) numbered 267551; fragment of pelvis (55 x 40 mm) numbered 269721; two fragments of leg bones numbered 269721 (apparently broken by Indians); fragment of articular portion of left femur numbered 269721; condyle of metapodial (immature), numbered 269721.

Although Baird labeled the loose wapiti teeth "Fossil teeth, Carlisle Cave," they are remarkably fresh in condition; only one (a molar) bears noticeable incrustations of limy mud. In their size and general appearance these two molars are scarcely distinguishable from the corresponding teeth of a male wapiti (No. 11747), killed on the Upper Missouri (catalogued March 7, 1871); the incisor, fully grown but not worn, seems to be equally similar to the corresponding tooth (somewhat worn) of a specimen from Yellowstone Park (No. 171889).

Odocoileus virginianus borealis Miller.—The bones of Virginia deer exceed in number the total of all the other mammalian remains that were found in the caves. Most of the leg bones have been broken, with the purposes, apparently, of exposing the marrow and of furnishing slender fragments that could be made into awl-like tools. There are somewhat more than 300 bones and bone-fragments of deer, representing nearly every part of the skeleton. It seems unnecessary to enumerate them. Those that have been kept in the Division of Mammals were catalogued under number 267553, those kept in the Division of Archeology were entered under numbers 14197, 22069–71.

Equus caballus Linnaeus.—Proximal end of left scapula, very obliquely broken and cut in the same apparently purposeful manner as many of the leg bones of deer and in 3 of those of wapiti. In condition the specimen appears to be rather fresh, but no more so than some of the bones of deer and wapiti. It bears no rodent tooth marks.

LITERATURE CITED

BAIRD, SPENCER F. 1850. On the bone caves of Pennsylvania. Proc. Amer. Assn. Adv. Sci., vol. 2, pp. 352–355.

——— 1857. [Description of *Neotoma magister*.] Mamm. North Amer., p. 498 (in account of *Neotoma occidentalis*).

RHOADS, SAMUEL N. 1894. A contribution to the life history of the Allegheny cave rat, Neotoma magister Baird. Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 213–221.

STONE, WITMER. 1893. Description of a new species of Neotoma from Pennsylvania. Proc. Acad. Nat. Sci. Philadelphia, 1893, pp. 16–18.

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THE NOMENCLATURE AND TYPE LOCALITIES OF CERTAIN OLD WORLD MAMMALS

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This paper is concluded from vol. 21, no. 2, p. 203.

GIRAFFIDAE

Cervus camelopardalis Linnaeus

In the original description of the giraffe (the typical subspecies of which is currently known as *Giraffa camelopardalis camelopardalis*), Linnaeus (Syst. Nat., ed. 10, vol. 1, p. 66, 1758) says: "Habitat in Aethiopia & Sennar." The references are: "Syst. Nat. [ed. 6 ?,] 13. n. 1. Bellon. itin. 119. Raj. quadr. 90. Hasselqu. act. Ups. 1750, p. 15. itin. 203." Belon saw his giraffe in captivity at Cairo, and Ray copied his description. Hasselquist (Iter Palaestinum, p. 204, 1757) gives the range as "Sennar & Aethiopia."

Lydekker (Proc. Zool. Soc. London 1904, vol. 1, p. 207, 1904) restricts the type locality to "the Abyssinian, or Kassala, side of Upper Nubia (Egyptian Sudan)." Thomas (Proc. Zool. Soc. London 1911, p. 150, 1911) says: "Type locality: Egypt (seen in captivity at Cairo)." Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 242, 1914) say: "Typical locality Eastern Sudan, or perhaps Abyssinia."

It is obvious that the place where an animal is found in captivity, and where it is not native, cannot be considered a proper type locality. Since the most definite, or most restricted, locality mentioned both by Hasselquist and by Linnaeus is Sennar, that would appear to be the most appropriate choice for a restricted type locality.

Nubia, according to Flower (Proc. Zool. Soc. London 1932, p. 370, 1932), extends south only to the 6th Cataract or about lat. 16° N. There seem to be no recent records of giraffes on the east of the Nile north of this latitude (*cf.* Anderson and de Winton, Zoology of Egypt: Mammalia, pp. 352–353, 1902), although Heuglin maintained (Reise in Nordost-Afrika, vol. 2, p. 134, 1877) that they ranged northward at least to lat. 18° N. Altogether, "Sennar giraffe" would appear to be a more suitable common name for the typical subspecies than "Nubian giraffe," which is employed by Lydekker and others.

Camelopardalis antiquorum Swainson

This name, introduced by Swainson (Geography and Classification of Animals, p. 95, 1835), barely escapes being a *nomen nudum* by reason of a reference to "Ruppell": "The *Camelopardalis antiquorum* Sw., or the northern giraffe, has recently been detected by Mr. Ruppell, whose elaborate observations have enabled us to characterise it as a distinct species from the giraffe of Southern Africa (*C. australis* Sw.)."

This reference may be rather safely taken to apply to the report on Rüppell's mammals by Cretzschmar (Atlas zu der Reise in nördlichen Afrika von Eduard Rüppell,

sect. 1, Zoologie, Säugethiere, 1826). This includes a description of "*Camelopardalis Giraffa* (Linné)" on pages 23–28, together with plate 8 (entire animal) and plate 9 (skulls).

According to Cretzschmar (p. 25), Rüppell obtained five specimens (two males, three females) on his journeys in Nubia and Kordofan. The species lives in small companies in all deserts south of Simrie [about lat. 17° N., long. 30° 45′ E.]. It even occurs east of the Blue Nile, and is common in the deserts of Darfur.

Cretzschmar's description is based primarily on Rüppell's adult male in the Senckenberg Museum. This specimen may be regarded as the principal cotype (I now make it the lectotype).

In Rüppell's own later work (Reisen in Nubien, Kordofan, etc., 1829) there are only a few passing references (pp. 69, 70, 123) to giraffes.

Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 244, 1914) remark: "The specimen figured by Jardine, which is stated to have come from the district between Sennar and Darfur (i. e. practically Kordofan), may be taken as the type, since Cretzschmar's description, on which Swainson's name is based, is insufficient."

It is true that Rüppell (Neue Wirbelthiere zu der Fauna von Abyssinien gehörig, Säugethiere, p. 24, 1835) considered Cretzschmar's plate 8 "insufficient." Yet it is difficult to see any justification for attempting to make the specimen figured by Jardine (Naturalist's Library, Mammalia, vol. 3, Ruminantia, pt. 1, pl. 21, 1835) the lectotype. It may have been one of the seven giraffes then living in London (*cf.* Rüppell, 1835, p. 24).

According to Jardine (1835, p. 187), the specimen he figured was "taken in the vicinity of Senaar and Darfour," not in "the district between Sennar and Darfur," as Lydekker and Blaine have it.

The true type locality may be considered the place at which the adult male in the Senckenberg Museum was taken. This, according to Schwarz (Ergebn. Zweit. Deutschen Zentral-Afrika-Exped. 1910–1911, vol. 1, Zool., no. 15, p. 898, footnote, 1920), is "Baggara el Homr im südlichen Kordofan." The Natur-Museum Senckenberg (*in litt.*, February 23, 1939) informs me that the specimen (No. 498, skin and skull) is still there, and that the locality given on the label is "Bagger el Homer, Kordofan." In Stieler's Atlas (pl. 8, 1932–34) there appears to be such a locality at about lat. 10° N., long. 28° E. Yet I find nothing in Rüppell's narrative to indicate that his travels extended to such a distance south of El Obeid.

Camelopardalis capensis Lesson

The first valid name bestowed upon the southern giraffe (currently known as *Giraffa camelopardalis capensis*) is the following: *Camelopardalis Capensis* Lesson, Nouv. Tabl. Règne Animal, Mammif., p. 168, 1842. Lesson gives no description but merely the following reference: "*La Giraffe*, Levaill., voy. pl. 8 et 9." The range is given as "Cap de Bonne Esp."

Levaillant (Voyage Intérieur Afrique, vol. 2, pp. 283–287, pls. 8–9, 1790) describes and figures a male and a female giraffe, but does not give the locality. He adds that he did not encounter the animal till his second journey. In the account of the latter (Second Voyage Intérieur Afrique, vol. 2, pp. 293–315, pl. 8, 1795), he describes the hunting of this animal and the taking of a specimen in the vicinity of the "*Gamma Rivier* (Rivière des lions)" in Great Namaqualand. This is presumably the "Löwen Fluss" of Stieler's Atlas (pl. 87, 1932–34), which is situated in South West Africa at approximately lat. 27° S., long. 18° E.

Lesson's original statement of locality ("Cape of Good Hope") need not be taken in too literal or restricted a sense.

According to W. L. Sclater (Mammals South Africa, vol. 1, p. 261, 1900), "Lichten-

stein (1812), ii, p. 277, . . . asserts that le Vaillant did not kill his specimen but purchased the skin in the Karee Mountains, south of the Orange River." However, I find nothing to this effect on the page indicated in Lichtenstein. Moreover, as Bryden remarks (Great and Small Game of Africa, p. 501, 1899), it is doubtful whether the range of the giraffe ever extended south of the Orange River. In any event, there is apparently nothing to show that Levaillant's plates were not prepared from the specimens he saw in Great Namaqualand, even if he may have brought back only a skin purchased south of the Orange River.

Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 256, 1914) give no more definite a type locality than "South Africa, north of the Orange River." On the other hand, Schwarz (Ergebn. Zweit. Deutschen Zentral-Afrika-Exped. 1910–1911, Zool., vol. 1, no. 15, p. 901, 1920) and Shortridge (Mammals South West Africa, vol. 2, p. 619, 1934) consider the "Löwenfluss" the type locality, and their interpretation may, I think, be safely followed.

BOVIDAE

Bos gaurus Hamilton Smith

The *Bos gaurus* of Hamilton Smith (Griffith's Anim. Kingdom, vol. 4, p. 399, 1827) is based primarily upon the "Gaour" of Geoffroy-Saint-Hilaire (Mém. Mus. Hist. Nat. Paris, vol. 9, p. 71, 1822). Geoffroy's description in turn is based upon a manuscript report by a Major Roughsedge. This description is unmistakable, despite Geoffroy's fantastic notion that the elongated dorsal vertebral processes project *externally*. Even his own translation of Roughsedge's report does not furnish a justifiable basis for such an assumption.

The type locality is stated by Geoffroy (p. 71) as follows: "les montagnes de Mine-Pout, montagnes à une centaine de lieues de la mer, et situées entre la côte de Coromandel et la fond de la baie de Bengale." Hamilton Smith (1827, p. 399) writes this as "the mountains of Mine-pont (Midnapoor?)." Lydekker (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 15, 1913) does not fix the locality any more definitely than "probably some part of India."

A far more precise statement is furnished by Traill (Edinburgh Philos. Jour., vol. 11, p. 336, 1824), who had before him "a MS. Journal of a hunting party"—evidently the same document from which Geoffroy had derived his information. Traill had also "the personal explanations of Captain Rogers, who was on that excursion." He continues: "The *gour*, according to that gentleman, occurs in several mountainous parts of Central India, but is chiefly found in Myn Pât, or Mine Paut, a high insulated mountain, with a tabular summit, in the province of Sergojah, in South Bahar."

This mountainous area may be located in the Times Atlas (1922, pl. 57), where it is represented as Mainpat, in the Sarguja Tributary States, at approximately lat. 23° N., long. 83° E. This, then, may be regarded as the type locality of the Indian gaur, whose current technical name is *Bibos gaurus gaurus* (Hamilton Smith).

Bos sondaicus Schlegel and Müller

The nomenclature of the Javan banteng is rather complicated. Lydekker (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 21, 1913) gives as the original reference: "*Bos banteng*, Raffles, History of Java, vol. 1, p. 111, 1817." Unfortunately Raffles uses no technical name, but merely a vernacular name, "bánténg."

Bos leucoprymnus Quoy and Gaimard (Voy. Astrolabe, zool., vol. 1, p. 140, 1830) would be an available name, except for the fact that it is based upon "a hybrid between the Banteng and the domestic species" (Blyth, Jour. Asiatic Soc. Bengal, vol. 11, pt. 1, p. 446, 1842).

In introducing *Bos Urus javanicus*, Wagner (in Schreber, Säugthiere, vol. 5, pt. 2,

p. 1593, 1838) quotes Raffles' account but adds practically nothing to it; the latter contains a single descriptive word ("red"), and it is not altogether clear whether this applies to a domesticated or a wild banteng. Wagner even suggests that it may apply to a feral race of the common cattle. Thus the name *javanicus* Wagner, if not a *nomen nudum*, may be regarded as indeterminable.

"*Bos bantinger*," as a name for the Javan wild ox, apparently originated on a label in the Leyden Museum, and spread thence to other museums (Schlegel and Müller, in Temminck's Verh. Natuurl. Geschiedenis Nederl. overz. bezittingen, Zool., p. 198, 1845). Variants of this name have crept into the literature, as will be noted below.

Probably one of these variants is *Bos Bentiger* Roulin (Dict. Univ. Hist. Nat., vol. 2, p. 619, 1842). This name is based on a skeleton in Paris—quite possibly the same hybrid specimen that Quoy and Gaimard named *leucoprymus*; and in that case the name *bentiger* would not be available for the wild banteng.

Blyth (1842, p. 445) cites "*B. Bentinger*, Temminck" as a synonym of "*Bos Sondaicus*, Muller."

Flower (List Vert. Animals Zool. Soc. London, 1828–1927, p. 260, 1929) cites, as the original reference, "*Bibos banting* J. E. Gray (*ex* Raffles *vernac.*), Glean. Menag. Knowsley Hoof. Quadr. p. 48, 1850." But Gray himself gives the following references: "*Bos Banting*, Raffles.—*Bos leucoprymnos*, Quoy & Gaim.—*Bos Bantiger*, Temm.—*Bos Sondaicus*, S. Müller, t. 35–39, animal and skull." As pointed out above, there is no "*Bos Banting*, Raffles." "*Bantiger*," presumably a manuscript name of Temminck's (or a variant thereof), is not listed by Sherborn (Index Animalium 1801–1850).

Bos sondaicus was introduced as a *nomen nudum* by Müller (in Temminck's Verh. Natuurl. Geschiedenis Nederl. overz. bezittingen, Zool., p. 45, 1839?). This name was eventually validated either by Blyth or by Schlegel and Müller.

Under the name of "*Bos Sondaicus*, Muller," Blyth (Jour. Asiatic Soc. Bengal, vol. 11, pt. 1, p. 445, pl. facing p. 470, fig. 5, 1842) describes and figures the horns of a "wild bull of Java."

Schlegel and Müller's validation of the name consists in the publication of plates 35–39 in Temminck. The date of these plates, while somewhat uncertain, is cited by Lydekker (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 21, 1913) as 1840. Sherborn indicates (Index Animalium 1801–1850, p. lxviii, 1922) that page 195 of the accompanying text, where the name also appears, was published in 1845. Wagner (in Schreber, Säugthiere, suppl. vol. 4, p. 517, 1844) gives a reference to plates 36, 37, and 39; and this would appear to be sufficient evidence that they were issued not later than 1844. If they did not appear prior to the latter part of 1842, then the *sondaicus* of Blyth would doubtless have priority. On the assumption, however, that they were issued in 1840, as indicated by Lydekker, we may credit the name *sondaicus* to Schlegel and Müller.

The original reference for the Javan banteng may then be cited as: *Bos sondaicus* Schlegel and Müller, in Temminck's Verh. Natuurl. Geschiedenis Nederl. overz. bezittingen, Zool., Mammalia, pls. 35–39, 1840(?); accompanying text (pp. 195 ff.) published in 1845.

The names and the type localities of the currently recognized subspecies of banteng are:

Bibos sondaicus sondaicus (Schlegel and Müller). Java.
Bibos sondaicus birmanicus (Lydekker). Burma.
Bibos sondaicus butleri (Lydekker). Perak, Malay Peninsula.
Bibos sondaicus lowi (Lydekker). Rejang Valley, North Borneo.

Poëphagus mutus Przewalski

This name was proposed for the wild yak (currently known as *Poephagus grunniens mutus*) in the original Russian edition of Przewalski's "Third Journey into Central Asia" (p. 191, pl. facing p. 190, 1883). In the German edition (Prschewalski, Reisen in

Tibet, 1884), *Poëphagus mutus* is proposed, without a description, on page 72, but is represented by a plate facing page 108. On page 72 there is also a footnote reference to a description in the author's "Die Mongolei und das Land der Tanguten," vol. 1, pp. 311–321 (presumably a Russian or a German edition). In the English edition (Prejevalsky, Mongolia, the Tangut Country, and the Solitudes of Northern Tibet, 1876), this description (under the name of *Poëphagus grunniens*) occurs in volume 2, pages 186–189, and is applied to the wild yak of northern Tibet in general.

But to judge by the "Reisen in Tibet" (pp. 71–72), the name *Poëphagus mutus* is applied particularly to the wild yak of the alpine region of the Nan Shan in the part of this range where Przewalski crossed it (approximately lat. 39° 20′ N., long. 95° E.), between the Anembar-Ula on the west and the Humboldt Range on the east. This, then, should be considered the type locality; it also happens to be the extreme northern limit of the wild yak's range. Lydekker (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 33, 1913) gives merely "Tibet" as the type locality, and does not extend the range farther north than the Kuen-lun.

Bos arnee Kerr

In the original description of *Bos bubalis* Linnaeus (Syst. Nat., ed. 10, vol. 1, p. 72, 1758), various statements (including "Habitat in Asia, cultus in Italia") indicate rather plainly that this name was based upon the domesticated Indian buffalo.

Since the wild buffalo of India is evidently distinguishable from the domesticated breeds (*cf.* Lydekker, The Ox and its Kindred, pp. 179–190, 1912; also Jour. Bombay Nat. Hist. Soc., vol. 36, no. 4, suppl., p. 31, 1933), it seems necessary to apply to the former a different subspecific name. The earliest one available seems to be *Bos Arnee* Kerr (Linnaeus' Anim. Kingdom, p. 336, pl. facing p. 356, upper lefthand fig., 1792). Kerr's description applies unmistakably to the wild buffalo rather than to the domesticated form. He states that it "inhabits India north from Bengal." As a restricted type locality, I suggest Kuch Bihar. A fine series of heads and horns, evidently from this area, is shown by Lydekker (Game of India, Burma, & Tibet, p. 75, fig. 10, 1900).

The name of the wild Indian buffalo will thus stand as *Bubalus bubalis arnee* (Kerr).

Lydekker (The Ox and its Kindred, pp. 226–227, 1912) discusses this case, without, however, concluding that different names are required for the wild and the tame Indian buffaloes.

Ovis arkal Eversmann

The taxonomy and nomenclature of the Transcaspian wild sheep are difficult and involved, owing chiefly to the fact that much of the essential literature is in Russian and either inaccessible to, or virtually unusable by, non-Russians.

The earliest name for these sheep, as cited by Sherborn (Index Animalium 1801–1850, p. 469, 1923), seems to be *Ovis arkal* Eversmann (*ex* Brandt *in litt.*), Estest. Istoriya Orenburghsk Kraya [Natural History of the Orenburg Government], vol. 2, p. 271, 1850. Nasonov (Bull. Acad. Impér. Sci. St.-Petersbourg, ser. 6, vol. 7, pt. 1, pp. 7, 14, 1913) cites this name as *Ovis arcal* Brandt in Eversmann, vol. 1, p. 271, 1840. I assume that the original spelling is *arkal*, as cited by Sherborn, and that the name is accompanied by a sufficient description to validate it. I also assume that the type locality is "Ust-Urt Plateau, Transcaspia," as given by Lydekker (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 91, 1913). Sushkin (Jour. Mammalogy, vol. 6, p. 149, 1925) cites the name as *Ovis arcar* Eversmann (presumably in error for *arkal*).

Ovis arkar Brandt (Beiträge Kenntniss Russ. Reiches, vol. 17, p. 310, 1852) is accompanied by no description but by a reference to Eversmann's work on Orenburg. It is therefore a pure synonym of *Ovis arkal* Eversmann. It is erroneously cited by Nasonov (1913, pp. 7, 14) as *Ovis arcar* Brandt.

Ovis arkal Blasius (Säugethiere Deutschlands, p. 469, figs. 243, 244, 1857; "aus der östlichen Umgegend des Caspischen Meeres") is a homonym and presumably a synonym of *Ovis arkal* Eversmann, and is invalid in any event.

This Transcaspian wild sheep is treated by various authors as a subspecies of different species. For example, Nasonov calls it *O. arcar arcar* Brandt; Lydekker, *O. vignei arkar* Brandt; and Sushkin, *O. orientalis arcar* Eversmann. I shall tentatively consider it conspecific with *O. vignei* Blyth (1841). On the assumption that *O. arkal* Eversmann dates from 1850, and not from 1840, the name will then stand as *O. vignei arkal* Eversmann.

Two other names, which have been applied respectively to the wild sheep of the Kopet-Dagh, southwestern Russian Turkestan, and to those of the mountains of Astrabad, Persia, remain to be considered. The first of these is *O. vignei varenzovi* Satunin (Zapiski Russkoe Geograf. Obshchestvo, Kavkazskii Otdiel, vol. 25, p. 41, 1905); it is cited by Lydekker (1913, p. 90) as "*Ovis vignei varentsowi*, Satunin, Zanukok Kaukas. Omd., vol. xxv, p. 41, 1905." Nasonov (Distr. géogr. moutons sauvages monde ancien, p. 46, 1923) and Sushkin (Jour. Mammalogy, vol. 6, p. 148, 1925) refer *varenzovi* to the synonymy of *O. cycloceros* Hutton, but I prefer to follow Lydekker (1913, p. 90) in considering it a provisional synonym of *O. vignei arkal*.

Ovis arcar dolgopolovi Nasonov (Bull. Acad. Impér. Sci. St.-Petersbourg, ser. 6, vol. 7, pt. 1, p. 25, 1913) "is founded on two heads collected by Karelin, it is believed, in the neighbourhood of Astrabad" (Lydekker, 1913, p. 91). Lydekker makes this name a provisional synonym of *O. vignei arkal*, while Sushkin (1925, p. 148) recognizes it as *O. orientalis dolgopolovi*, giving its range as "mountains of Astrabad Province, Persia, and east to Afghanistan." Without the means of forming an independent opinion, I shall follow Lydekker in his disposition of the name *dolgopolovi*, and shall provisionally treat all the wild sheep of southwestern Russian Turkestan and of northeastern Persia (east of the Elburz Mountains) under the name of *O. vignei arkal* Eversmann.

Antilope lervia Pallas

In Pallas's original description (Spicil. Zool., fasc. 12, p. 12, 1777), the Barbary sheep (now known as *Ammotragus lervia*) is said to be "Africae borealiori propria"; and a reference is given to "Fishtall s. Lerwee Shaw. *itin.* (ed. gall.), *I. p.* 313." Lydekker says (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 123, 1913): "Typical locality Mauretania." This statement is acceptable only on condition that it applies to the Mauretania of the ancients, which comprised the present Morocco and part of Algeria. It can not be accepted as applying to the modern Mauretania, a part of French West Africa. Rothschild remarks (Novit. Zool., vol. 20, no. 2, p. 459, 1913): "Pallas founded his *lervia* on Shaw's Fishtall or Lerwee, and this was procured in Algeria." In the Amsterdam edition of his "Reizen" (p. 274, 1780), and doubtless in the other editions, Shaw includes his "Fishtall" in an account of the mammals of Algeria and Tunisia, but gives no specific locality. The Department of Oran, western Algeria, is here suggested as the restricted type locality.

Capra pyrenaica Schinz

This name was proposed by Schinz (Neue Denkschr. Allg. Schweiz. Gesell. Naturwiss., vol. 2, p. 9, 1838) for the Pyrenean ibex, with a range "in den spanischen Pyrenäen, auf den Gebirgen der Sierra de Randa und der Königreiches Granada." The only definite Pyrenean locality mentioned in Schinz's description is "nahe bei dem Passe Maladetta" (p. 17). This was evidently the provenance of the specimen in the Zürich Museum, and quite possibly of the three specimens in the Mainz Museum, which together furnished the basis of the type description. Thus the type locality may be restricted to the vicinity of the Maladetta Pass, in Huesca, Spain.

Cabrera (Proc. Zool. Soc. London 1911, p. 974, 1911) has made the adult male specimen at Mainz the lectotype. According to the Director of the Mainz Naturhistorisches Museum (*in litt.*, June 18, 1938), this specimen is merely recorded as from the "Pyrenees," the exact locality and the name of the collector being unknown.

Aegoceros (Capra) falconeri Hügel and Wagner

There has been no uniformity in citing the authority for this name, which was originally published as "*Aegoceros* (*Capra*) *Falconeri* Hügel" by A. Wagner (Gelehrte Anzeigen K. Bayer. Akad. Wissen. München, vol. 9, no. 183, p. 430, 1839). Wagner makes it plain (p. 431) that Hügel proposed the manuscript name "*Capra Falconeri*," and that he himself took the latter's manuscript description for a starting point and added to it notes of his own, after examining the type in Wien. This establishes a joint responsibility of authorship. The name should accordingly be cited as of Hügel and Wagner, in Wagner. The current combination is *Capra falconeri falconeri* (Hügel and Wagner).

No definite type locality is given in the original description, although there is incidental mention (p. 431) of "Kaschmir" and of "die höchsten Theile des tibetanischen Himalayas." In a later work of Hügel's (Kaschmir, vol. 4, pt. 2, p. 579, 1844), Wagner states that the type came "aus den höchsten Theilen des tibetanischen Himaleyas." Blanford refers (Fauna Brit. India, Mammalia, p. 506, 1891) to "the true *Capra falconeri* of Astor and Baltistan." Finally, Lydekker writes (Cat. Ungulate Mammals Brit. Mus., vol. 1, p. 162, 1913): "Typical locality Astor." This last restriction of the type locality may be considered valid. It is in accord with the animal's common name, Astor markhor.

Antilope dorcas Pallas

The bontebok of South Africa is currently known as *Damaliscus pygargus* (Pallas). Pallas gave three descriptions of it: *Antilope Dorcas*, Misc. Zool., p. 6, 1766; *Antilope Pygargus*, Spicil. Zool., fasc. 1, p. 10, 1767; and *Antilope Pygarga*, Spicil. Zool., fasc. 12, p. 15, 1777. In his publication of 1767 he attempted to restrict the name *Antilope dorcas* to the dorcas gazelle (described by Linnaeus in 1758 as *Capra dorcas*), and he bestowed the new name *A. pygargus* on the Bontebok. However, his original description of *Antilope dorcas* applies quite unmistakably to the bontebok.

The more modern authorities, such as Sclater and Thomas (Book of Antelopes, vol. 1, p. 73, 1895) and Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 2, p. 33, 1914), do not list the *Antilope dorcas* of Pallas (1766) as a synonym of *Capra dorcas* Linnaeus (1758), but indicate that the former name is preoccupied by the latter. This course was entirely proper during the period when both species were included in the single genus *Antilope*, but now that they have been placed in different genera (*Damaliscus* and *Gazella*), the *dorcas* of Pallas becomes available again. The original reference of the bontebok is therefore *Antilope Dorcas* Pallas, Misc. Zool., p. 6, 1766; and the combination to be used henceforth is *Damaliscus dorcas* (Pallas). *A. pygargus* Pallas (1767) becomes a synonym.

In the first two of Pallas's descriptions it is difficult to make out any definite range of the species, although a reference to a figure in Houttuyn (Natuurl. Hist., vol. 3, pl. 24, fig. 2, 1761–1773), said to have been selected from Johann Burmann's African drawings, suggests the Cape of Good Hope region, since Burmann is known to have been particularly interested in the plants of that region. In the third description (1777), Pallas says: "Africana, forte tamen citeriori Asiae communis."

Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 2, p. 34, 1914) give as type locality "Cape Colony," which is far more than the total range of the species.

Apparently the first mention of a definite locality is by Masson (Philos. Trans., vol. 66, pt. 1, p. 287, 1776), who met with the bontebok at the "Caffer Kuyl's Rivier," between Swellendam and Mossel Bay. This is the modern Kaffir Kuils River, in the Riversdale district, Cape Province, and it is here suggested as the restricted type locality.

Bos gnou Zimmermann

Zimmermann's *Bos Gnou* (Spec. Zool. Geogr., p. 372, 1777)—currently known as *Connochaetes gnou* or the white-tailed gnu—was based upon the "Gnou" of Allamand (in Buffon, Hist. Nat., ed. de Hollande, vol. 15, p. 113, pl. 4, year?). Allamand's account was based in part upon a specimen obtained by a Captain Gordon during a journey of 200 leagues from the Cape of Good Hope into the interior. Zimmermann merely places the animal in the interior of Africa, between the Cape of Good Hope and the Tropic of Cancer. Buffon (Hist. Nat., suppl., vol. 6, pp. 89–100, pls. 8–9, 1782) gives a further account, in which he includes the one previously presented by Allamand. The localities particularly mentioned by Buffon were at varying distances from the Cape of Good Hope—150, 180, or 200 leagues (say 375 to 500 miles). Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 2, p. 52, 1914) restrict the type locality to "Cape Colony." The Colesberg district of the Cape Province would fall within the distances mentioned by Buffon from the Cape of Good Hope. "From 1850 to 1857" the species "was still fairly abundant between Colesberg and Hanover" (Sclater and Thomas, Book of Antelopes, vol. 1, p. 114, 1895). Accordingly I venture to suggest the Colesberg district as a more restricted type locality.

Antilope dama Pallas

Buffon (Hist. Nat., vol. 12, p. 213, pl. 34, 1764) describes and figures a gazelle "that, according to M. Adanson, is called Nangueur or Nanguer in Senegal." Adanson had traveled extensively in Senegal, and had presumably brought from there the animal that Buffon describes. The latter identifies his species with the "*dama*" of Pliny. Pallas (Misc. Zool., p. 5, 1766) proposes "*Antilope Dama* Plinii," but the only definite reference he gives here is to the nanguer of Buffon, and he states that Africa is its habitat.

Senegal was generally accepted as the type locality of *A. dama* until Neumann (Sitz.-ber. Gesell. Naturf. Freunde Berlin 1906, no. 9, p. 238) proposed to restrict the name to the animal of the Lake Chad region. But Cabrera has appropriately remarked (Trab. Mus. Nac. Cienc. Nat., Ser. Zool., no. 57, p. 354, 1932) that in the time of Buffon and Pallas not only the Chad fauna but Lake Chad itself were entirely unknown. Cabrera also stated (pp. 353–354) that the subspecies of *Gazella dama* (as the animal is currently known) are not so well defined as generally supposed, and that there is much individual variation. Thus Senegal remains the type locality of *A. dama* Pallas, and *Gazella dama permista* Neumann (1906, p. 239), based upon a zoo specimen from no more definite a locality than "Senegambia," falls as a synonym.

It seems worth while to call attention to these findings of Cabrera's, since Neumann's *permista* is still recognized in such late works as those of Ward (Records of Big Game, African and Asiatic Sections, ed. 10, p. 190, 1935) and Allen (Checklist of African Mammals, Bull. Mus. Comp. Zoöl., vol. 83, p. 529, 1939).

Antilope equina Desmarest

The roan antelope (currently known as *Hippotragus equinus equinus*) was first described by Desmarest (Nouv. Dict. Hist. Nat., ed. 1, vol. 24, p. 4, 1804) as *Antilope equina* "Geoffr." Since this manuscript name of Geoffroy's had not been previously published, Desmarest is technically the author.

Sclater and Thomas (Book of Antelopes, vol. 4, p. 17, 1899) remark: "Desmarest states that the exact locality of this [the type] specimen was unknown, but we think it may be safely assumed to have been from the Cape." This restriction of the type locality need not be interpreted in too literal or narrow a sense, for the same authors add (p. 19): "The Roan Antelope appears never to have existed south of the Orange River." Thus Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 136, 1914) are doubtless justified in their statement: "Type locality S. Africa north of the Orange River."

"The roan was first recognized as a new antelope under the Sechuana name of Tâkhaitse, by Messrs. Truter and Somerville, who in 1801, saw one in the neighbourhood of the Kuruman river in Bechuanaland; the animal was not obtained, but was sketched from the distance by the artist Daniell, who accompanied the expedition" (W. L. Sclater, Mammals S. Africa, vol. 1, p. 220, 1900). More explicitly, the locality seems to have been somewhat to the northeast of Kuruman, "near Latakoo" (apparently the later Litakun, at approximately lat. 27° S., long. 24°E.). Therefore the vicinity of Litakun, British Bechuanaland, is here suggested as a final restriction of the type locality. This has the advantage of reducing to absolute synonymy the following four later names, all of which were based upon Daniell's "Takhaitse" and therefore have the identical type locality: *Capra aethiopica* Schinz (1821), *Capra jubata* Goldfuss (1824), *Antilope barbata* H. Smith (1827), and *Antilope truteri* Fischer (1829).

Aegocerus niger var. **kirkii** J. E. Gray

In a paper on the mammals of "Zambesia," Kirk refers (Proc. Zool. Soc. London 1864, pp. 658–659, 1865) to an individual of "*Aegoceros niger*" "shot on the Batoka Hills," and adds: "Its colour was quite tawny, marked like the Sable Antelope on the face; but in the whole herd there was not a single one with the dark-coloured hair." On a previous page (656) Kirk clearly indicates the location of the Batoka Hills in the following remark: "In the plains above Victoria Falls, near the Batoka Hills."

Kirk's note is obviously the basis of *Aegocerus niger* var. *Kirkii* J. E. Gray (Cat. Ruminants Brit. Mus., p. 35, 1872). Gray gives no locality, but merely remarks: "Entirely tawny-coloured, with the face marked like the Sable Antelope. Forming herds, without any black specimens being intermixed."

Sclater and Thomas (Book of Antelopes, vol. 4, p. 32, 1899) and Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 144, 1914) cite Gray's name (in each case inaccurately), but give no more definite type locality than "Zambesia."

Roosevelt and Heller do not say quite all that might be said when they write (Life-histories African Game Animals, vol. 1, pp. 333–334, 1914): "The name *kirki*, given by Gray in 1872 to rufous individuals of the sable recorded by Sir John Kirk from the Zambesi, has been by some naturalists confused with the East African race. Gray's name, however, was only based on the observations made by Sir John Kirk and was not founded on a specimen or a definite locality and does not apply to this race."

It is safe to consider that the type locality of the subspecies named by Gray is the Batoka Hills, in the southern part of Northern Rhodesia, more or less north of Victoria Falls.

On the question of the validity of this subspecies—whose name should stand as *Hippotragus niger kirkii* (J. E. Gray)—the following remarks of Selous (The Gun at Home and Abroad, the Big Game of Africa & Europe, p. 89, 1914) are apropos: "The bulls and the old cows—to the South of the Zambesi—become almost absolutely black, and the mane grows so long that on the shoulders it falls over to either side. . . . South of the Zambesi forty inches is a good average length for sable antelope horns, and few are likely to be met with there exceeding a length of forty-five inches over the curve.

In North-West Rhodesia, however, they grow larger and often exceed a length of forty-eight inches, and sometimes even exceed fifty inches. . . . To the north of the Zambesi sable antelope cows are much redder than they are to the south of that river, and never, I believe, turn quite black."

The range of *kirkii* may be considered provisionally to include Northern Rhodesia, southern Belgian Congo, Nyasaland, and inland parts of Portuguese East Africa north of the Zambesi.

Oreas livingstonii P. L. Sclater

Livingstone's eland (*Taurotragus oryx livingstonii*) was originally described as *Oreas livingstonii* by Sclater (Proc. Zool. Soc. London 1864, p. 105, 1864). This spelling of the specific name was not a typographical error, and it may not be emended to *livingstonei*, as a majority of recent authors apparently attempt to do. Sclater evidently had no specimen, but he quotes descriptive notes by Speke on elands at Inenge, in Usagara (in the present Tanganyika Territory), and by Kirk on others on the left bank of the Zambesi, in the vicinity of the Kafue. He also mentions the eland described in Livingstone's "Travels," and states that he names the animal after its discoverer. Sclater and Thomas (Book of Antelopes, vol. 4, p. 197, 1900) give, as the first reference under *livingstonii*; "*New or Striped Variety of the Eland*, Livingstone, Missionary Travels, p. 210 (cum fig.) (1857)." Lydekker (Game Animals of Africa, p. 306, footnote, 1908) is doubtless justified, therefore, in taking "as the type of this form the eland obtained by Livingstone."

The type locality is not exactly "Sesheke, north of the Victoria Falls of the Zambesi," as stated by Lydekker and Blaine (Cat. Ungulate Mammals Brit. Mus., vol. 3, p. 212, 1914). From Livingstone's account it is evident that his eland was taken near the village of Sekhosi on the Zambesi, farther upstream than Sesheke, and about 115 miles northwest of Victoria Falls.

Lydekker and Blaine (1914, pp. 213, 214) recognize *Taurotragus oryx niediecki* (Matschie) and *T. o. kaufmanni* (Matschie), but I am much inclined to agree with Shortridge (Mammals of South West Africa, vol. 2, p. 607, 1934) in regarding these names as synonyms of *livingstonii*. The differences ascribed by Matschie to his two forms may be regarded as minor variations not worthy of nomenclatural recognition. It is apparently not generally realized that the type localities of all three of these forms lie within a radius of little more than 100 miles.

Oreas oreas kaufmanni Matschie (Deutsche Jäger-Zeitung, vol. 58, p. 119, 1912) was based on a head from the Caprivi between the Chobe and the Zambesi Rivers. This type locality is perhaps no more than 40 miles from that of *livingstonii*.

Oreas oryx niediecki Matschie (Sitz.-ber. Ges. Naturf. Freunde Berlin 1913, no. 4, p. 249, 1913) was based on two specimens from the vicinity of Banga on the Kafue River, Northern Rhodesia, between long. 26° and 27° E. (*cf.* p. 256). This is approximately 175 miles from the type locality of *livingstonii*. Lydekker and Blaine (1914, p. 213) are in error in stating that the type locality of *niediecki* is "Zambesia" (*i.e.*, Portuguese East Africa).

The original eland taken and very sketchily described by Livingstone was apparently not preserved, and even topotypes do not seem to have been available to those who have subsequently described other subspecies.

Taurotragus derbianus congolanicus Millais

This name, as introduced by Millais (Far Away up the Nile, p. 241, 1924), is not a misspelling of Rothschild's *congolanus*, as indicated by Allen (Bull. Mus. Comp. Zoöl., vol. 83, p. 543, 1939), but represents the proposal of a new subspecies. It "is known by

a single specimen (horns and frontlet only), 29½ ins. in length, shot by the late Sir Henry Stanley at Stanley Falls on his first expedition up the Congo. . . . It is now in Captain Otter's museum."

A brief search through Stanley's principal works reveals no record of such a specimen. In any event, the alleged type locality, in the midst of the Rain Forest of the Upper Congo, is an impossible place for the natural occurrence of any eland. The type specimen should be reëxamined.

American Committee for International Wild Life Protection, Philadelphia, Pa.

GEOGRAPHIC VARIATION IN THE MEADOW MOUSE IN BRITISH COLUMBIA AND SOUTHEASTERN ALASKA

By Frederick H. Dale

Opportunity has recently been afforded me to examine specimens of *Microtus pennsylvanicus* in the collections of the California Museum of Vertebrate Zoology, including especially good representations of the species from parts of British Columbia and the adjoining coast of southeastern Alaska. The primary purpose of the study was to ascertain the nature of geographic variation displayed by this species within the range indicated, and this part of the study revealed the need for taxonomic revision of the forms examined.

In the following account, statements of geographic variation, unless otherwise indicated, refer to *Microtus pennsylvanicus* in the region west of the Continental Divide, between the forty-ninth and sixtieth parallels of north latitude, including Admiralty Island and that part of the coast of Alaska between these latitudes.

Grateful acknowledgment is made to E. Raymond Hall of the California Museum of Vertebrate Zoology, for the use of its facilities and specimens, including the Morris M. Green collection there. I am similarly grateful to Hartley H. T. Jackson and Robert T. Orr of the U. S. Biological Survey and the California Academy of Sciences, respectively, for the use of supplementary material.

Size variation.—Microtus pennsylvanicus increases in size from north to south and from high to low altitudes. Hall (1935) has noted this trend in *Microtus montanus* from Nevada. Specimens of *M. californicus* and *M. longicaudus* in the Museum also reveal that in each of these species the animals are of increasingly large size toward the southern part of their geographic ranges.

The occurrence of a size-gradient correlated with altitude was reported by Davis (1938) in pocket gophers (*Thomomys*), but he suggested that the shallower soil of the mountain tops, as contrasted with the deeper soil of the valleys, was a limiting factor in the size of the montane forms. Soil has not

been studied across the region here concerned to determine whether or not a correlation exists between that factor and the size of *Microtus pennsylvanicus*. Nevertheless, there is a correlation between large size and high temperature. Some of the localities from which specimens were collected have no weather stations nearby. The consequent lack of recorded temperatures prevents the ascertaining of the exact degree of correlation of size with temperature. The accompanying table, in which series of *M. pennsylvanicus* are listed according to the condylobasal length of skull, gives an indication that such correlation exists, although several gaps in weather data must be filled in by supposition as to the probable annual mean temperature. Weather data for British Columbia in the table are from Whitford, Craig, and Leavitt (1918). That for Taku River is as reported for Juneau by Brooks, Abbe, and Goode (1906).

LOCALITY	NUMBER OF SPECIMENS	CONDYLOBASAL LENGTH	ANNUAL MEAN TEMPERATURE	ANNUAL PRECIPITATION
Crows Nest Station	6	25.0 mm.		12 in.
Hazelton	7	25.3 mm.		
Atlin	17	25.4 mm.	30°	12 in.
Telegraph Creek	12	25.5 mm.		
Indianpoint Lake	9	25.7 mm.	35°	36 in.
Taku River, Alaska	13	26.2 mm.	41°	84 in.
Anahim Lake	16	26.7 mm.		
Okanagan Lake	10	27.6 mm.	46°	12 in.

Probably the correlation between size and temperature is not perfect. The great variation in size exhibited by specimens of *Microtus* from one locality makes comparisons of different populations for this feature an inexact process. Nevertheless, the table indicates that, in general, the individuals from cold localities are smaller than those from warm places.

There is evidently no simple relationship between size of *Microtus* and amount of annual precipitation. The smallest and the largest specimens are from localities with little rainfall.

The general correlation found to exist between temperature and size is not necessarily an indication that size is a somatic character and that temperature exerts a direct control on growth. To the contrary, the slight average differences in size distinguishing the populations from Atlin, Telegraph Creek, and Hazelton, which places, according to Swarth (1926), have temperatures considerably different from one another suggest that the genetic basis for size is but little influenced by such temperature differences as obtained there.

Length of appendages.—Length of tail and length of hind foot are collectors' data taken from labels on specimens. These measurements are not reliable

within narrow limits because of the slightly different techniques employed by different preparators. The record of length of tail may vary considerably, even in the same specimen, depending on the time that elapses after death before the measurement is taken. Howell (1924) found that in *Microtus californicus sanctidiegi* the variation resulting from this cause may be 5 per cent.

No correlation has been found, in this study, between relative length of appendages and climatic factors, possibly because of unavoidable inaccuracies in measurements. The series with the shortest hind feet, relative to length of head and body, are those from Okanagan Lake and Telegraph Creek, localities that appear to have little in common with respect to climatic factors. Taku River and Crows Nest Station are both represented by series with relatively long hind feet, although the two localities present entirely different conditions with respect to temperature, rainfall, and elevation.

Length of tail and length of hind foot are correlated in a general way, in that those specimens with long tails have long hind feet. Nevertheless, the correlation is not perfect. The series from Admiralty Island, for example, has the longest hind foot, relative to length of body, but ranks third in relative length of tail.

As compared with the nearest mainland population (Taku River), the animals from Admiralty Island have relatively larger hind feet, by a slight degree, but relatively shorter tails (38.5 per cent of head and body length as opposed to 42.5 per cent). This recalls the fact noted by Hall (1938) that insular populations of *Peromyscus maniculatus* in Georgia Strait, British Columbia, have shorter tails than mainland mice, and that the degree of difference may be correlated with the distance from the mainland.

Color.—The most northerly forms are reddish, as opposed to blackish in the southern populations. The northern populations examined include only those from the Coast Ranges, the Alaskan coast and the one insular race. These northern localities have more rainfall than the southern localities from which specimens are available. Nevertheless, the light, reddish form from this region includes populations from Atlin, with an annual precipitation of 12 inches, and Taku River, with over 80 inches. Telegraph Creek, according to Swarth, 1926, has about the same rainfall as Atlin, while Hazelton has considerably more. Thus, it appears that precipitation is not a potent factor in influencing coloration of *Microtus pennsylvanicus* within this area. The specimens from Crows Nest Station are pale, but those from Okanagan Lake, where the annual precipitation is about the same, are nearly black. No correlation was found between the amount of annual precipitation or relative humidity (which probably parallels precipitation in a general way in this region) and the degree of darkness of coloration, such as is found in many species in the southwestern United States.

Study of variations in size, length of appendages, and color shows that

none of these features behaves exactly according to laws of geographic variation as formulated by Bergmann, Allen, and Gloger. In size, *Microtus pennsylvanicus* appears to contradict Bergmann's Law, which states that in closely related warm-blooded animals the larger live in the north and the smaller in the south. Allen (1907), recognizing that some forms increase in size toward the southern parts of their ranges, suggested a modification of Bergmann's Law. He postulated that the kinds of animals whose individuals are larger toward the south are those whose greatest numerical development is also in the south, and whose "hypothetical center of distribution" is there.

It appears to me that neither Bergmann's Law nor Allen's modification of it can apply to *Microtus pennsylvanicus*. For the genus *Microtus*, and also for microtines in general, the centers of numerical development are certainly northern, rather than southern, and the Holarctic distribution of the genus indicates a Boreal origin and center of dispersal. Furthermore, *Microtus pennsylvanicus*, west of the Rocky Mountains at least, is most abundant in the north.

Hesse, Allee, and Schmidt (1937, p. 388) recognize that *Microtus pennsylvanicus* is larger in Pennsylvania than in Labrador. They suggest that "the burrowing animals may form exceptions [to Bergmann's Rule], since they . . . can withdraw from the winter cold."

Allen's Law, which asserts that appendages are relatively shorter in northern forms than in closely related southern forms, while not contradicted to the same extent as is Bergmann's Law, receives no support from the material here reported on.

Gloger's Law states that southern forms tend to be black, brown, and especially rust-red, while northern forms tend to be paler and grayer. While it is true that the northern forms of this species are paler than the southern forms, the preponderance of red is in the northern populations. Gloger's Law may be held to apply in a modified form in this instance.

Skull characters.—No simple gradient of any kind appears to exist in skull characters other than in size. The northern series are relatively wide across the zygomatic arches (more than 56.5 per cent of condylobasal length), while the southern races are narrower in this measurement (55.6 and 55.7). The specimens from Crows Nest Station resemble the northern forms in this respect. In general, relative breadth is greater in the smaller specimens. Apparently the factors responsible for increase in size have influenced the length of the skull more than its breadth.

Nasals are, on the average, relatively longer in the northern series, although there is considerable variation in this character. The larger skulls are somewhat more angular and ridged than the smaller skulls at comparable ages. This may be in response to a need for stronger muscle attachments in the larger animals.

Taxonomy.—In applying names to the geographic variants studied, three new subspecies of *Microtus pennsylvanicus* are here recognized.

For one of these an old name is already available. Two new names are proposed. A fourth form, heretofore considered as a distinct species, is treated as a subspecies of *M. pennsylvanicus*. Five valid subspecies are recognized within the area treated.

All specimens listed in the following accounts, unless otherwise noted, are in the California Museum of Vertebrate Zoology. Unless otherwise indicated, characters given in diagnoses are those exhibited by series from near the type localities. Variations from these characters in referred specimens are indicated under *"Remarks."*

TABLE 1. *Measurements, in millimeters, of adults of both sexes of Microtus pennsylvanicus*

SUBSPECIES	LOCALITY	NUMBER OF SPECIMENS AVERAGED	TOTAL LENGTH	LENGTH OF TAIL	CONDYLOBASAL LENGTH	LENGTH OF NASAL	BREADTH ACROSS ZYGOMATIC ARCHES	BREADTH ACROSS AUDITORY BULLAE	LENGTH OF MAXILLARY TOOTH-ROW
drummondii	50 mi. N Jasper House and Muskeg Creek, Alberta	6	148.7	40.3	24.6	6.7	13.7	11.6	6.1
drummondii	Crows Nest Station, B. C.	6	139.7	37.0	25.0	6.4	14.2	11.8	6.1
microcephalus	Indianpoint Lake, B. C.	9	144.1	39.0	25.7	6.7	14.0	—	6.3
funebris	Nr. Okanagan Lake, B. C.	10	166.1	43.4	27.6	7.2	15.4	12.8	6.6
funebris	Anahim Lake, B. C.	16	150.4	41.5	26.7	6.6	14.9	12.4	6.4
rubidus	Atlin, B. C.	17	155.5	42.0	25.4	7.0	14.3	12.0	6.1
rubidus	Nr. Telegraph Creek, B. C.	12	156.3	38.5	25.5	7.0	14.7	12.0	6.3
rubidus	Hazelton, B. C.	7	157.7	47.4	25.3	6.9	14.4	11.8	6.0
rubidus	Taku River, Alaska	13	157.0	46.6	26.0	7.0	14.7	11.7	6.2
admiraltiae	Admiralty Island, Alaska	15	152.9	42.7	26.7	6.9	14.9	12.2	6.4

Series reported in the table of measurements may include specimens from nearby localities other than the place designated, but in each instance they were judged to be from a geographical unit small enough to give a fair indication of the characters of the animals from the locality.

Microtus pennsylvanicus drummondii (Audubon and Bachman)

?1829. *Arvicola novoboracensis* Richardson, Fauna Boreali-Americana, p. 126.

1854. *Arvicola drummondii* Audubon and Bachman, Quadr. North Amer., vol. 3, p. 166.

1897. [*Microtus*] *drummondi* Trouessart, Catal. Mamm. viv. foss., p. 563.

1899. *Microtus stonei* Allen (part), Bull. Amer. Mus. Nat. Hist., vol. 12, p. 5.

1912. *Microtus pennsylvanicus drummondi* Hollister, Canadian Alpine Jour., special number, p. 23.

Type.—Type specimen not designated. Described from specimens collected in

summer by Drummond in the Rocky Mountains, hence somewhere near the head of the Athabasca River, in Alberta. According to Bailey (1900) this is in the vicinity of Jasper House. Also, see below under *Remarks*.

Range.—In British Columbia restricted to territory near crest of Rocky Mountains and possibly that part of northeastern British Columbia east of the Continental Divide (the status of *M. stonei* (Allen) from Liard River, judged by Bailey (1900) to be a synonym of *M. drummondii*, is not here considered because of lack of material from that region). Limits of range unknown.

Diagnosis.—(Specimens from 50 mi. N Jasper House, and Muskeg Creek, Alberta). Size: Small (see measurements). Color: Pale, some specimens slightly reddish but not blackish. Skull: Small, with narrow maxillary spread but relatively wide in interorbital region; mandible slender; lower incisors weak.

Comparisons.—*Microtus p. drummondii* differs from *M. p. fontigenus* and *M. p. modestus* in its smaller size and paler color. For comparisons with the subspecies newly named beyond, see accounts of those forms.

Remarks.—Uncertainty has been expressed as to the locality from which *M. p. drummondii* was first described. Richardson (1829) referred to it as "on the Rocky Mountains," and Audubon and Bachman (1854, p. 167) give the locality as "Valleys of the Rocky Mountains." Rhoads (1894) attempted to set up Lac La Hache, British Columbia, as the type locality, while Allen (1899) believed it better to permit the name to lapse as unidentifiable. The original description, however, was based on a specimen collected in summer. This limits the possible localities to those on the east slope of the Rocky Mountains, as Drummond was on the west slope only after the snow was too deep to permit collecting. Furthermore, the only summer spent by him in the Rocky Mountains was one when he was near the head of the Athabasca River. The locality given by Bailey ("vicinity of Jasper House") is in accordance with these facts; his selection is apparently justified.

Specimens from Crows Nest Station are colored like those from Jasper House, but have slightly heavier mandibles and lower incisors. Those from the plains to the east are darker and larger.

Specimens examined.—Total number, 45, as follows (localities in this paper are listed by geographical position from northwest to southeast by province or territory): **British Columbia:** Crows Nest Station, on Canadian Pacific Railroad, 4444 ft., 6. **Alberta:** (all in Biol. Surv. coll.) 50 mi. N Jasper House, 3; Muskeg Creek, 20 mi. from its mouth, 2; Muskeg Creek, 15 mi. from its mouth, 1; Athabasca River, 30 mi. above Athabasca Landing, 9; 5 mi. above Athabasca Landing, 5; "S. Edmonton," 19.

Microtus pennsylvanicus microcephalus (Rhoads)

1894. *Arvicola* (*Mynomes*) *microcephalus* Rhoads, Proc. Acad. Nat. Sci. Philadelphia, 1894, p. 286; described under the name *Arvicola* (*Mynomes*) *drummondi*, p. 287.

Type.—None (Rhoads' description based on adult male, no. 418, collection of S. N. Rhoads, Lac La Hache, British Columbia, June 30, 1892).

Range.—Interior, wet belt of British Columbia, including Cariboo, Monashee, and Selkirk mountains, and that part of the interior plateau east of the Fraser River and north of Kamloops Lake.

Diagnosis.—Size: Medium (see measurements). Color: Dark, with strong reddish and brownish tones. Skull: Small to medium sized; narrow across the zygomatic arches but relatively wide in interorbital region; maxillary tooth-row relatively long; mandible relatively heavy.

Comparisons.—From *M. p. drummondii*, *M. p. microcephalus* differs in larger size, darker color, heavier and flatter upper incisors, longer and stouter lower incisors, and

heavier mandible. For comparisons with *M. p. funebris* and *M. p. rubidus*, see accounts of those forms.

Remarks.—The form here recognized as a distinct subspecies was first referred to by Rhoads (1894), who states that he had previously described, in manuscript, under the name *Arvicola* (*Mynomes*) *microcephalus*, specimens from Lac La Hache and Fields, British Columbia. Nevertheless, since the specimens fitted the description of *Arvicola drummondii* Audubon and Bachman (1854), he proposed that they be made the basis for the "full restoration of that species" and described them as "topotypes" of *drummondii*. The name *microcephalus* was thus used in connection with specimens which are described in the same paper, albeit under another name, and therefore must be used for the animals from Lac La Hache.

The type locality is near the edge of the range assigned to *M. p. microcephalus*, and for this reason the characters given under diagnosis of the subspecies were ascertained by examination of specimens from Indianpoint Lake and the vicinity of Mount Robson Park, British Columbia, as more nearly representative.

Specimens examined.—Total number, 62, all from British Columbia, as follows: Indianpoint Lake, 15 mi. NE Barkerville, 44; Cottonwood P. O., 5; Mt. Robson, Mt. Robson Park, 5; Rainbow Station, Moose Lake, Mt. Robson Park, 1; Lac La Hache, 1; Summit of Monashee Pass, 5000 ft., Monashee Mts., 1; Cranbrook, 5.

Microtus pennsylvanicus funebris, subsp. nov.

Type.—Male, adult, skin and skull; no. 77482, Mus. Vert. Zool.; 1450 ft., Coldstream, 3½ mi. southeast of Vernon, British Columbia; August 2, 1937; collected by T. P. Maslin, Jr.; original no. 741.

Range.—Southern part of arid, interior belt and southern Coast Ranges east of main summit, from Okanagan Valley, on the southeast, to Anahim Lake, near head of Dean River, on the northwest, including the lower Fraser and Thompson river valleys, British Columbia.

Diagnosis.—Size: Large (see measurements). Color: Dark; upper parts almost black, with some reddish tones in most specimens; underparts pearl gray or with a slight buffy tint in a few individuals. Skull: Large and angular; interorbital region narrow and sharply ridged in adults; all measurements of breadth relatively small.

Comparisons.—*M. p. funebris* differs from all other British Columbian races of the species in its large size and dark coloration, in which characters it approaches specimens of *M. p. modestus* from southern Idaho.

Remarks.—The characters which set off this subspecies from other British Columbian forms are best developed in the warm, dry Okanagan Valley. This valley lies within the Upper Sonoran and Transition life-zones and, with the Kamloops area, is the only area of Upper Sonoran Life-zone within British Columbia. Specimens from higher altitudes, for example those from Pennask Lake, differ in smaller size and redder color. Those from Anahim Lake differ in smaller size and slightly lighter color. The nasals are relatively and actually shorter, and the mandible is shorter and stouter in the Anahim Lake specimens, but it seems best to refer this population to *M. p. funebris*, which it resembles in its general features.

Specimens examined.—Total number, 43, all from British Columbia, as follows: Island in Anahim Lake, 7; Anahim Lake, 11; Tyaughton Lake, 6 mi. NE Minto Mine, Bridge River, 1; Lake Pennask, 3; Okanagan, 1; S. end Swan Lake, 15; Vernon, 1; 1135 ft., ½ mi. NE Okanagan Landing, Okanagan Lake, 1; Okanagan Landing, 1; 1450 ft., Coldstream, 3½ mi. SE Vernon, 1; 1 mi. S Summerland, Okanagan Lake, 1.

Microtus pennsylvanicus rubidus, subsp. nov.

Type.—Male, adult, skin and skull; no. 30758, Mus. Vert. Zool.; Sawmill Lake, near Telegraph Creek, British Columbia; June 12, 1919; collected by Joseph Dixon; original no. 7361.

Range.—Valleys of Coast Ranges of British Columbia, between Hazelton and Atlin, and adjoining coast of Alaska.

Diagnosis.—Size: Small to medium (see measurements). Color: Upper parts reddish brown with very little black; underparts gray or buffy. Skull: Relatively broad across zygomatic arches, interorbital region, and rostrum; nasals relatively long.

Comparisons.—This race differs from all other British Columbian races of the species in its combination of reddish color and lack of blackish tones. From *Microtus p. funebris* it differs further in smaller size, and from *M. p. microcephalus* in relatively longer nasals and broader zygomatic arches. For comparison with *M. p. admiraltiae* see account of that form.

Remarks.—The color of *M. p. rubidus* is remarkably constant, the slight variations between populations being insignificant when compared with the degree to which the subspecies differs from other races in this feature. Size of skull is also remarkably constant in the three populations from the Coast Ranges, although the average size is greater in the population from Taku River. Specimens from localities other than along the Stikine River have relatively longer appendages than those from the type locality.

Specimens examined.—Total number, 235, as follows: **Alaska:** Taku River, 45; Sergeif I., mouth of Stikine River, 1. **British Columbia:** Atlin, 103 (90 in Calif. Acad. Sci.); Spruce Mountain, 5000 ft., near Atlin, 1; Sawmill Lake, near Telegraph Creek, 16; Stikine River at Glenora, 20; Stikine River at Doch-da-on Creek, 18; Kispiox Valley, 23 mi. NE Hazelton, 13; Nine-mile Mountain, 4500 ft., NE Hazelton, 1; Hazelton, 17.

Microtus pennsylvanicus admiraltiae Heller

1909. *Microtus admiraltiae* Heller. Univ. California Publ. Zool., vol. 5, p. 256.

Type.—Female, adult, skin and skull; no. 118, Mus. Vert. Zool.; Windfall Harbor, Admiralty Island, Alaska; May 4, 1907; collected by Joseph Dixon; original no. 25.

Range.—Known only from Admiralty Island, Alaska.

Diagnosis.—Size: Small (see measurements); hind foot relatively large, averaging 18.5 per cent of body length; tail medium, averaging 38.5 per cent of body length. Color: In spring pelage, upper parts reddish with but little black; underparts buffy with plumbeous hairs showing through. Skull: Medium-sized; flattened in interorbital region and but slightly arched at posterior end of nasals; nasals usually projecting farthest posteriorly at the lateral margins; upper incisors but slightly recurved.

Comparisons.—Compared with topotypes of *Microtus p. rubidus* the present race differs as follows: Nasals shorter, actually and relatively; interorbital region flatter; upper incisors projecting farther anteriorly; tail actually and relatively shorter.

Remarks.—In color and size, *M. p. admiraltiae* closely approaches the mainland forms. Its most distinctive features are the flattened interorbital region and the slightly recurved upper incisors. The former is suggestive of an age character, although the age span represented in the series at hand is sufficient to indicate that in this instance it is actually a racial character. The shape of the incisors is a character of degree, and does not appear to be fundamental enough to indicate specific separation of these animals from the mainland races of *M. pennsylvanicus* even though no intermediate condition is demonstrated for this character.

Since there is difference of opinion in the treatment of insular populations, perhaps further discussion on this point is desirable. The population from Admiralty Island

is here considered as a subspecies of *M. pennsylvanicus* because its relation to that species seems to me to be much closer than that between distinct species of mainland forms. There seems to be but little doubt that this population has been derived from *M. pennsylvanicus* and has undergone but minor changes since its isolation. Furthermore, the treatment of this population as a subspecies of the mainland species appears to me to imply that failure of any certain character to intergrade with that of the nearest mainland population is probably the result of a geographical barrier rather than a racial incompatibility.

Specimens examined.—Total number, 55, all from Admiralty Island, Alaska, as follows: Windfall Harbor, 38; Lake west of Mole Harbor, 1; Mole Harbor, 6; Hawk Inlet, 7; Hasselborg Lake, 3.

LITERATURE CITED

Allen, J. A. 1899. On mammals from the Northwest Territory collected by Mr. A. J. Stone. Bull. Amer. Mus. Nat. Hist., vol. 12, pp. 1–9.

1907. The influence of physical conditions in the genesis of species. Smithsonian Report for 1905, no. 1687, pp. 375–402.

Audubon, J. J., and John Bachman. 1854. The quadrupeds of North America, vol. 3, 348 pp., 55 pls. V. G. Audubon, New York.

Bailey, V. 1900. Revision of American voles of the genus Microtus. North Amer. Fauna, no. 17, pp. 1–88, 5 pls., 17 figs. in text.

Brooks, A. H., C. Abbe, and R. V. Goode. 1906. The geography and geology of Alaska. U. S. Geol. Surv., Professional Paper no. 45, pp. 327 + iii, 34 pls., 6 figs.

Davis, W. B. 1938. Relation of size of pocket gophers to soil and altitude. Jour. Mamm., vol. 19, pp. 338–342.

Hall, E. R. 1935. Nevadan races of the Microtus montanus group of meadow mice. Univ. California Publ. Zool., vol. 40, pp. 417–427, 1 fig. in text.

1938. Variation among insular mammals of Georgia Strait, British Columbia. American Nat., vol. 72, pp. 453–463, 2 figs. in text, 2 tables.

Heller, E. 1909. The Mammals [*in* Birds and mammals of the 1907 Alexander expedition to southeastern Alaska]. Univ. California Publ. Zool., vol. 5, pp. 245–264, 1 pl., 2 figs. in text.

Hesse, R., W. C. Allee, and K. P. Schmidt. 1937. Ecological animal geography, pp. i–xiv + 1–597, figs. 1–135. John Wiley and Sons. New York.

Hollister, N. 1912. Mammals of the Alpine Club expedition to the Mount Robson Region. Canadian Alpine Jour., Special number, pp. 1–44, 5 pls.

Howell, A. B. 1924. Individual and age variation in Microtus montanus yosemite. Jour. Agric. Research, vol. 28, pp. 977–1016, 1 pl., 25 figs. in text, 4 tables.

Rhoads, S. N. 1894. Descriptions of a new subgenus and new species of arvicoline rodents from British Columbia and Washington. Proc. Acad. Nat. Sci. Philadelphia, pp. 282–288, 1 fig. in text.

Richardson, John. 1829. Fauna Boreali-Americana, 284 pp., 24 pls. London.

Swarth, H. S. 1926. Report on a collection of birds and mammals from the Atlin region, northern British Columbia. Univ. California Publ. Zool., vol. 30, pp. 51–162, 4 pls., 11 figs. in text.

Whitford, H. N., R. D. Craig, and C. Leavitt. 1918. Forests of British Columbia. Canada Commission of Conservation, Committee on Forests, pp. viii + 409, 28 pls., 21 maps. Ottawa.

California Museum of Vertebrate Zoology, University of California, Berkeley, California.

A NEW SPECIES OF POCKET GOPHER (GEOMYS) FROM EASTERN GEORGIA

By H. B. Sherman

The occurrence of pocket gophers in the vicinity of Savannah, Georgia, was recorded as early as 1802 by Mitchill (Merriam, North Amer. Fauna no. 8, p. 115, 1895). But judging from the material that I have been able to find in existing collections, it was more than a century before specimens from this region were preserved. Two specimens in the U. S. Biological Survey collection, taken in 1909 by W. J. Hoxie, with locality noted as "7 miles north of Savannah, Ga.," are remarkable for the presence of a fontanel on each side of the skull between the parietal and temporal bones. These were at first suspected of being abnormalities. However, similar fontanels are present in a specimen which I took in the same region in September, 1939, and in 8 others taken there by B. A. Barrington two months later. These 11 specimens leave no reason to doubt that the occurrence of fontanels is a normal condition with this colony of animals. Since they differ in this, as well as in other respects, from other known members of the *Geomys tuza* group, they are here described as a distinct species.

In my record of specimens examined, the abbreviation USBS, refers to the U. S. Biological Survey; MCZ, to the Museum of Comparative Zoology; BAB, and HBS to the collections of B. A. Barrington and H. B. Sherman, respectively.

Geomys fontanelus new species

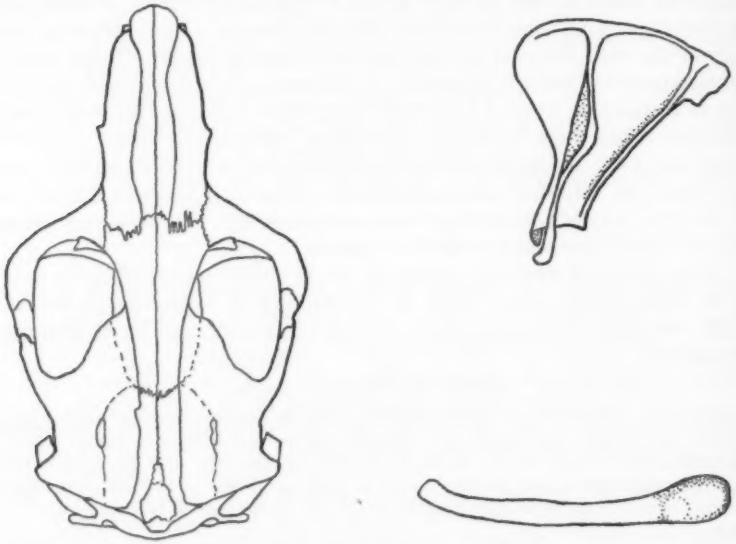
Holotype.—Adult male, no. 2097, collection of H. B. Sherman; trapped and prepared by B. A. Barrington; original no. 45. Paratypes, 5 males, 5 females as follows: 159497–98, USBS, skins with skulls; 46, 47, 49, BAB; 2086, 2094–96, 2098 HBS, skins with skeletons except for limb bones distal to the elbow and knee joints. The baculum is absent in specimens 2094 and 2095 HBS and the distal end of this bone is lacking in the holotype.

Diagnostic characters.—The presence of a fontanel between the parietal and temporal bones (in reference to which this species is named); nasals much compressed in about the anterior third of their extent, as shown in the accompanying figure of the skull of the holotype; size about the same as in *G. tuza tuza*, but color darker than in the typical subspecies.

Range.—Known only from the type locality. This is an area only a few square miles in extent, lying about 7 miles northwest of Savannah, labeled "Norfolk very fine sand" on the soil survey map of Chatham Co., Georgia, U. S. Dept. Agriculture, 1912.

Coloration.—In the holotype, the mid-dorsal region from head to rump is a dark grayish brown; laterally this color shades into areas suffused with chestnut or russet, with the brightest coloring on the sides of the head, shoulders and hips; underparts grayer than sides. The forearms and wrists are about the same color as the underparts, except the outer sides of the wrists which are a little lighter. In 6 of the paratypes the outer sides of the wrists are nearly white. Two of the females, 159497 USBS and 2086 HBS, have so many white hairs on the upper and lateral sides of the head as to make the pelage nearly white in places.

Measurements (in mm.)—Measurements of the two sexes are given separately, because males of this and other species of the *G. tuza* group average larger than females. The 8 specimens taken by Barrington were in rigor mortis and quite stiff when measured. This may explain the fact that the tail length of these specimens average less than in the other 3 specimens of the type series. Males.—The first measurements, of the holotype, are followed by the extremes of measurements of the male paratypes. Total length, 277 (276–222); tail, 90 (105–70); foot, 34 (34–30). Females.—The first measurements are of specimen 2086 HBS, measured before rigor mortis occurred, and are followed by the extremes of the female paratypes. Total length, 242 (250–232); tail, 84 (95–61); foot, 32 (34–30). Skull measurements, arranged in the same order as the external measurements, are as follows: Skull length, measured from the dorsal edge of the



Dorsal view of skull and lateral views of the scapula and baculum of *Geomys fontanelus*.

foramen magnum to the anterior projection of the premaxillaries between the incisors; males, 53.8 (52.6–42.2); mastoid width, 26.7 (27.0–22.8); zygomatic width, 31.7 (32.3–25.2); interorbital width, 6.5 (6.7–6.3); greatest width of rostrum, 11.1 (11.3–9.2) Females.—Skull length, 47.3 (45.6–42.9); mastoid width, 24.2 (24.5–23.2); zygomatic width, 28.4 (28.2–25.0); interorbital width, 6.8 (6.9–6.3); greatest width of rostrum, 10.3 (10.4–9.2).

The scapula of *G. fontanelus* is also peculiar in that, as compared with numerous specimens from other parts of Georgia and from Florida, its teres major fossa is the largest, and its outline is the most nearly rectangular. The shape and position of this fossa at the caudal angle of the scapula (of the holotype) is shown in the accompanying figure. This scapula, measured from the glenoid fossa to the vertebral border opposite the spine, is 23.0 mm. in length. Its width, measured from the cranial angle perpendicu-

lar to the axillary border, is 16.3 mm. Thus measured, the width is 70.9 per cent of the length, making it one of the widest scapulae examined.

The baculum of this species does not differ greatly from bacula of *Geomys* taken at such widely separated regions as Kingsland, Georgia, Gainesville, Wauchula, Satsuma, Welaka, and Eau Gallie, Florida. However, the number of bacula available for comparison is scarcely sufficient to establish satisfactorily the amount of individual variation. Consequently its value as a taxonomic character in distinguishing species of the *Geomys tuza* group is uncertain. Its appearance in lateral view (cf. no. 2096 HBS) is figured. This bone measures 10.0 mm. in length.

Remarks.—*Geomys fontanelus* appears to be most closely related to *G. tuza tuza*, the only other *Geomys* known to occur in eastern Georgia as far north as Savannah. In these two species there is a close similarity in the shape of the palate, shape of the teeth, and general configuration of the skull. The bullae of *fontanelus* are, however, slightly larger than those of *tuza*. The localities lying nearest to the range of *fontanelus*, from which I have seen specimens of *G. tuza*, are Sterling, Glynn Co., and Hursmans Lake, Georgia, which is about midway between Savannah and Augusta. Specimens from these two localities in the MCZ collection average about the same as specimens of typical *tuza* from Augusta.

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A NEW KANGAROO RAT FROM OKLAHOMA

By Albert H. Trowbridge and H. L. Whitaker

Among the specimens obtained during an investigation of the mammals of Oklahoma there is a series of kangaroo rats from the floodplain of the South Canadian River, near Norman, Oklahoma. These specimens differ so much from both *Dipodomys elator* Merriam and *Dipodomys ordii richardsoni* (Allen), the two representatives of the genus hitherto known to occur in Oklahoma, as to indicate that they represent an undescribed form. Since this form is not known to intergrade with its nearest relative, *D. o. richardsoni*, it may be given specific rank as follows:

Dipodomys oklahomae new species

Oklahoma Kangaroo Rat

Dipodomys ordii richardonsi, Blair, Amer. Midl. Nat. vol. 22, p. 116, July, 1939. Specimens from near Norman, Oklahoma—not *Dipodops richardsoni* J. A. Allen, 1891.

Type.—From the north bank of the South Canadian River, 2¼ miles south of Norman, Cleveland County, Oklahoma. Female young adult, skin and skull, no. 265454, U. S. National Museum (Biological Survey collection), collected by H. L. Whitaker, March 16, 1934. Original number, University of Oklahoma Museum of Zoology no. 14517. X-catalogue no. 29312.

Distribution.—Known only from the flood plain of the South Canadian River (west as far as Minco, Canadian County, and east as far as Lexington, Cleveland County) where it lives in the low sand dunes of the flood plain north of the river channel.

General Characters.—A five-toed, grayish buffy species, most nearly related to *Dipodomys ordii richardsoni* (J. A. Allen) but distinguishable by paler coloration, smaller size, shorter tail, and larger, heavier skull.

Color.—Type: Upper parts near vinaceous-buff, purest along the sides; top of head and back thinly mixed with brownish-black, the combination resulting in a somewhat greyish-buffy tone; dark facial markings only moderately developed. Entire underparts, post-auricular and orbital areas, fore limbs, hind feet above, and tail at extreme base all around, pure white; tail above light brown shading toward cinnamon drab through the distal half, below brown near base, the brown area narrowing to a point about 40 mm. beyond base posteriorly; the remainder of the tail's lower surface and sides white, except the extreme tip, which is brownish; soles of hind feet brownish to base of toes, which are white, tinged with vinaceous-buff. The upper parts of a specimen taken in August are more clearly vinaceous-buff. The upper parts of young about half grown are duller and less buffy along the sides, somewhat darker gray in general color tone than the adults. (Color terms are those of Ridgway, 1912).

Skull.—Similar to that of *Dipodomys ordii richardsoni*, but in mature animals (as indicated by the condition of the molars) the skull is somewhat shorter and relatively heavier and wider; nasals shorter and relatively broader, projecting less anteriorly from the incisors; rostrum broader and heavier; face of the zygomatic process of the maxillary broader and more nearly quadrate in outline; interorbital area relatively wider. The interparietal, although variable, averages slightly longer and decidediy wider than that of *richardsoni*; intermastoid area wider; supraoccipital greatly reduced; basioccipital shorter and broader, almost filling the area between the tympanic bullae; posterior lacerated foramen greatly reduced; jugal slightly heavier.

Measurements.—Type: Total length, 243 mm.; tail vertebrae, 128; hind foot, 41. Average of 10 specimens of both sexes (9 topotypes and the type), 244.8 (extremes, 234–260); 130.5 (120–142); 39.7 (37–42). Average of 10 adult *D. o. richardsoni* from Pendennis, Kansas: 265 (257–289); 148.1 (142–160); 42. *Skull* (type): occipitonasal length 36.5; greatest breadth (between outer sides of auditory bullae), 23.8; breadth across maxillary arches, 21.7; interorbital space (taken just behind the lacrimals), 13.3; length of nasals, 14.1; width of nasals (in front of incisors), 3.9; least width of the supraoccipital, 3.3; maxillary tooth row (alveoli), 5.0; width of cutting edge of upper incisors, 2.2; width of bony palate taken between the first molars, 3.4; interparietal, 4 x 3.1.

The average skull measurements of 7 adults of *oklahomae* from the type locality, 5 adults of *richardsoni* from Pendennis, Kansas, 3 adult *richardsoni* from Canadian, Texas, and three young males of *richardsoni* from Oklahoma (1 from Cherokee, 1 from Edith, and 1 from Waynoka) are respectively as follows: occipitonasal length, 37.0, 38.5, 38.0, 38.2; greatest breadth, 23.9, 25.6, 24.7, 24.0; breadth of maxillary arches, 21.6, 22.1, 21.1, 20.9; length of nasals, 14.1, 14.8, 14.7, 14.6; width of nasals, 4.2, 4.3, 3.8, 4.1; width of rostrum, 6.8, 6.6, 6.6, 6.4; least width of supraoccipital, 3.2, 2.6, 2.4, 2.6; breadth of palate at M_1, 3.4, 3.6, 3.9, 3.5; interparietal, 4.0 x 3.1, 3.9 x 2.3, 3.9 x 2.3, 3.1 x 2.2.

Specimens examined.—Oklahoma: North bank of South Canadian River, 2¼ miles south of Norman, Cleveland County (type-locality), 19; north bank South Canadian River, 4 miles north of Minco, Canadian County, 1.

Ecology.—Dipodomys oklahomae is a strictly pioneer species, preferring to occupy small active sand dunes or blowouts on stabilized dunes. Prevailing south winds pile the sand on the north side of the Canadian River; the rats, therefore, seem to be limited strictly to the flood plain north of the river.

Since the dunes of their normal habitat are soon flattened by wind or floods, or are promptly stabilized and covered with vegetation, the location of the colonies of the rats changes rapidly. In March, 1934, a number of occupied burrows were found at the edges of blowouts and on other active parts of a high, partially stabilized dune near Norman. Three years later, in February, the dune was well covered with vegetation

and the rats were gone. Occupation of many smaller dunes has been even more transitory.

Normally the most extensive colonies of *oklahomae* occur near the river channel. The burrows are located in low, scantily vegetated dunes, in dunes at the bases of small cottonwood trees, or among piles of driftwood that have been covered by drifting sand.

The habitat of the rats usually includes only a few species of plants, none of which exists in extensive stands. One of the most prevalent of these is cocklebur, *Xanthium* sp. During the winter the seeds of this plant appear to provide most of the food of the rats, although captive rats consistently refused them. On several occasions piles of sand mixed with refuse, mainly the remains of cockleburs, have been found at the entrances to burrows. Storage chambers containing as much as a quart of burs are commonly found close to the burrows; they are merely small holes in which the burs are stored and covered with sand. During the winter, well-worn paths may lead from a kangaroo rat colony to patches of cocklebur as far away as 200 feet.

The cheek pockets of trapped rats seldom contain anything but the trap bait. The pockets of one specimen from Norman, however, contained several seeds of a wild bean, *Strophostyles helvola*, and the pouches of another contained two seeds of lesser ragweed, *Ambrosia artemisiifolia*, one seed of *Euphorbia* sp., 29 seeds of sand grass, *Triplasis purpurea*, one seed of switch grass, *Panicum virgatum*, dry inflorescences and fragments of leaves of *Panicum* sp., probably *P. virgatum.*, and a small amount of fine sand. The determinations of the seeds from the latter specimen were made by A. C. Martin, Section of Food Habits Research, Bureau of Biological Survey, United States Department of the Interior.

Occasionally the tracks of an individual rat may be followed for a mile; but such extensive travels seem to be unusual and they do not appear to be feeding excursions. Journeys of as much as a quarter of a mile seem to be common. None of our observations includes tracks or trails to indicate that the rats drink water. Captive rats drank, but apparently had to learn how after they were captured.

Living as they do in the low dunes of the low-lying parts of the flood plain, the rats are subject to hazard from flood water; on rare occasions floods of unusual proportions may reduce or nearly eliminate the population. During the winter of 1937, kangaroo rats were numerous at many places on the flood plain. The next spring one of the worst floods of the South Canadian River in many years occurred. The water covered most of the area inhabited by the rats and the following November only one small colony could be found. It was on a low stabilized cottonwood dune on the north bank of the river, just south of the Norman dump. This dune and the surrounding area was covered by a relatively dense growth of grasses and herbs, and was ecologically more mature than any previously observed habitat occupied by the rats. This seems to substantiate the possible importance of floods as a factor in species survival as indicated by Grinnell (Jour. Mamm., vol. 20, pp. 62–64) and Blair (Jour. Mamm., vol. 20, pp. 304–306).

Before the flood, specimens of this form had been secured without difficulty, but we were unable to take a single adult from this remaining colony. Although traps were set in fours at entrances to the burrows and baited with dried rolled oats, dried prunes, nut meats, peanut butter mixtures and other baits, only four half-grown young animals were caught.

We wish to express to Dr. A. I. Ortenburger, Department of Zoology, University of Oklahoma, our thanks for the loan of specimens within his charge.

Fish and Wildlife Service, U. S. Department of Interior, Washington, D. C., and Soil Conservation Service, U. S. Department of Agriculture, Muskogee, Oklahoma.

A NEW RACE OF THE HARVEST MOUSE (REITHRODONTOMYS) FROM VIRGINIA

By Arthur H. Howell

When my revision of the American harvest mice (North Amer. Fauna no. 36, 1914) was being prepared, there were available from Virginia only three specimens of the genus. These were referred doubtfully to *Reithrodontomys humulis impiger*. Since then two specimens have been collected by Ray Greenfield near Takoma Park, Maryland, thus extending the known range of the genus north of the Potomac River. During 1937 and 1938, John B. Lewis collected near Amelia, Virginia, a series of 22 specimens of harvest mice; this series, with those previously known from the vicinity of Washington, D. C., shows clearly that the harvest mice of interior Virginia belong to an undescribed race, which is here named

Reithrodontomys humulis virginianus subsp. nov.

Virginia Harvest Mouse

Type.—Collected at Amelia, Virginia, February 15, 1938, by John B. Lewis; adult male, no. 263815, U. S. Natl. Museum, (Biological Survey collection); original number 158 (28258, X-catalog).

Range.—Known from central Virginia (Amelia County) north to the vicinity of Washington, D. C.

Subspecific characters.—Similar to *R. humulis humulis*, but paler and more grayish, lacking the clear snuff brown shown by *humulis*, and with a more distinct band of blackish brown along the median line of the back; sides of head and body paler, more or less washed with light pinkish cinnamon, which color forms a definite lateral line next to the belly; tail distinctly bicolor, fuscous above, grayish white below; ears fuscous; feet white. Skull not appreciably different from that of *humulis*.

Measurements.—Average of 10 specimens from the type locality: Total length, 117.2 (110–125); tail vertebrae, 51.8 (45–56); hind foot, 16.2. *Skull.*—Average of 8 from type locality: Greatest length, 18.7 (18.3–19.1); cranial breadth, 9.5 (9.2–9.9); length of nasals, 6.7 (6.4–7.1).

Specimens examined.—Total number, 26, from localities as follows: Maryland: Takoma Park (near Riggs Mill), 2. Virginia: Alexandria, 1; Falls Church, 1; Amelia, 20; Truxillo, 2.

Fish and Wildlife Service, U. S. Department of Interior, Washington, D. C.

FIELD MICE (APODEMUS) FROM THE OUTER HEBRIDES, SCOTLAND

By Tom Warwick

When Hinton (1914) redescribed *Apodemus hebridensis hebridensis* de Winton from the Island of Lewis his material from the other islands of the Outer Hebrides did not permit him to come to any conclusion about the status of the mice occurring there. Since that time no work has been done on the systematics of the mice of these islands. During the past two years I have collected material from Barra, Mingulay, and Berneray (Barra Head) and this is described below.

Apodemus hebridensis hebridensis de Winton

Habitat.—Isles of Lewis and Barra, Outer Hebrides.

Field mice from Barra are distinctly paler in color on the upper parts than the series of skins from various localities in Lewis; older specimens are more russet in color than young adults. The flanks are also much paler than in Lewis specimens; the underside is silvery, with no trace of a buff suffusion, and the gray underfur seldom shows through. Because of the light colored flanks the line of demarcation between the dorsal and ventral surfaces is not sharp, but is slightly irregular. The pectoral spot is often absent but it is always small and sometimes is represented by only a few buff colored hairs. Adult pelage had been assumed by all mice having a greater body weight than 17 grams. The skull measurements when compared with those of *A. h. hebridensis* from Lewis (table 1) show very few differences. The cranial width is somewhat greater, the palatal foramina are shorter but no wider, the coronal length of the maxillary teeth is greater, and the tympanic bullae are somewhat smaller and flatter. Some of these differences were noted by Hinton (1914) in the single skull from Barra then available. In table 2 absolute and percentage dimensions of juveniles and adult males and females are given. Animals weighing 22 grams and over are here taken as being adult. All individuals of this weight had assumed adult pelage and the testes of the males were of mature size. Baker (1930) finds that *Apodemus sylvaticus sylvaticus* usually becomes adult at a weight of 15 grams and over.

Barra field mice are of essentially the same size as true *A. h. hebridensis* from Lewis; but they have a relatively much shorter tail, and the relative lengths of their hind feet and ears are also somewhat reduced. The hind foot and ear are usually 22.5–23.5 and 14–15 mm. respectively. The material examined comprised 46 specimens (33 ♂, 13 ♀) of which 34 were adults (27 ♂, 7 ♀); they were collected in July, 1936 and 1937, when I was a member of the Edinburgh University Biological Society's Expeditions to Barra. All the mice were caught at Vaslain, north Barra, in patches of rye (Warwick, 1938).

The close relationship between the field mice of Barra and Lewis is indicated by the similarity of the skulls. In the absence of stronger evidence than is at present available the creation of a new subspecies would only obscure true affinities. The status of these mice with regard to *A. h. hebridensis* will be made plainer when adequate material has been collected on North Uist, South Uist, and Benbecula. In the single specimen from South Uist in the Royal Scottish Museum, Edinburgh, the back is as bright as in Barra mice.

Apodemus hebridensis nesiticus, subsp. nov.

Type.—Adult male, skin and skull, no. B. M. 39.464, British Museum; collected April 1, 1938, at Skipisdale, Mingulay, Outer Hebrides, by Tom Warwick; original number, M. 17.

TABLE 1. *Absolute and percentage cranial dimensions of field mice from Lewis, Barra, Mingulay and Berneray*

The number of specimens measured is given in brackets. All measurements are in millimetres.

		LEWIS	BARRA	MINGULAY	BERNERAY
Condylo-basal length	Range	20.7–25.0 (9)	21.8–24.4 (17)	23.2–25.7 (25)	23.2–25.2 (5)
	Average	23.4	22.8	24.6	24.0
Occipito-nasal length	Range	24.9–27.4 (9)	24.7–26.4 (10)	25.9–28.2 (20)	26.0–26.8 (4)
	Average	25.8	25.3	26.8	26.3
Zygomatic breadth	Range	12.5–13.7 (7)	12.5–13.9 (17)	13.2–14.6 (16)	12.7–13.6 (4)
	Average	13.2	12.9	13.7	13.2
Inter-orbital breadth	Range	4.1– 4.5 (9)	4.0– 4.5 (17)	4.2– 4.8 (25)	4.1– 4.4 (5)
	Average	4.3	4.2	4.4	4.3
Cranial breadth	Range	11.2–12.0 (9)	11.4–12.4 (17)	11.6–12.7 (16)	11.7–12.1 (5)
	Average	11.7	11.7	12.0	11.9
Cranial depth middle	Range	7.6– 8.8 (9)	7.8– 8.5 (15)	8.0– 8.7 (13)	7.8– 8.6 (5)
	Average	8.3	8.2	8.4	8.1
Condyle to 3rd. molar	Range	9.5–11.1 (9)	10.3–11.5 (17)	10.9–12.5 (25)	11.0–11.9 (5)
	Average	10.9	10.7	11.7	11.3
Condyle to front of bulla	Range	6.1– 6.8 (9)	5.9– 6.4 (16)	6.3– 7.1 (23)	6.4– 7.1 (5)
	Average	6.4	6.3	6.7	6.6
Nasal length	Range	8.3–10.3 (9)	9.0– 9.7 (12)	9.7–10.9 (22)	9.8–10.3 (5)
	Average	9.6	9.2	10.1	10.0
Nasal width	Range	2.5– 3.0 (9)	2.4– 2.7 (12)	2.7– 3.2 (23)	2.8– 2.9 (5)
	Average	2.8	2.6	2.9	2.9
Palatal length	Range	9.7–12.1 (9)	10.6–11.9 (17)	11.4–12.9 (25)	11.2–12.0 (5)
	Average	11.3	11.1	12.0	11.5
Diastema	Range	6.3– 7.2 (9)	6.1– 7.1 (17)	6.7– 8.0 (25)	6.7– 7.4 (5)
	Average	6.9	6.7	7.8	6.9
Incisive foramina length	Range	5.5– 6.0 (9)	4.9– 5.8 (17)	5.6– 6.6 (25)	5.8– 6.1 (5)
	Average	5.7	5.3	6.2	5.9
Incisive foramina width	Range	1.8– 2.2 (9)	1.7– 2.0 (17)	1.8– 2.4 (25)	1.9– 2.1 (5)
	Average	1.9	1.8	2.2	2.0
Rostral breadth	Range	3.6– 4.0 (9)	3.3– 3.9 (17)	3.9– 4.2 (25)	3.8– 3.9 (5)
	Average	3.8	3.7	4.0	3.8
Masseteric plate, least width	Range	2.1– 2.6 (9)	2.1– 2.4 (17)	2.4– 2.8 (25)	2.5– 2.7 (5)
	Average	2.3	2.3	2.6	2.6
Maxillary teeth, length	Range	3.6– 4.0 (9)	3.9– 4.0 (17)	3.9– 4.1 (25)	4.0– 4.2 (5)
	Average	3.9	4.0	4.0	4.1
Mesopterygoid fossa, length	Range		4.18– 4.84 (19)	4.65– 5.18 (26)	4.72– 5.07 (5)
	Average		4.47	4.92	4.88
Mesopterygoid fossa, width at middle	Range		1.23– 1.54 (19)	0.88– 1.35 (26)	0.93– 1.15 (5)
	Average		1.33	1.16	1.00
Distance between hamulars	Range		1.93– 2.67 (19)	2.04– 2.79 (26)	2.17– 2.50 (5)
	Average		2.33	2.32	2.35
Mandible, length	Range	12.8– 16.5 (9)	13.4– 14.8 (21)	14.4–16.4 (23)	15.0–16.2 (5)
	Average	14.6	14.2	15.3	15.5
Mandibular teeth, length	Range	3.8– 4.1 (9)	3.9– 4.2 (20)	3.9– 4.2 (20)	4.0– 4.2 (5)
	Average	4.0	4.1	4.1	4.1

Habitat.—Mingulay and Berneray (Barra Head), Outer Hebrides, Scotland.

Relations.—Geographically this subspecies must be related to *A. h. hebridensis*, which it approaches closely in size, pelage, and relative body dimensions; but from which it diverges markedly in cranial characters.

In coloration the type specimen is slightly paler on the upper parts than are mice from most localities in Lewis; but the back and flanks are distinctly darker than in Barra mice in summer pelage. The line of demarcation is more sharply defined than in the Barra mice, and is a little irregular. The underside is silvery; but the darker underfur shows through. There is a prominent, but not bright, pectoral spot. The tail is markedly bicolored. In the skull the mesopterygoid fossa is long, narrow, parallel-sided for the first half of its length, and pointed anteriorly; this feature distinguishes it from *A. h. hebridensis*. The teeth are partly worn. Head and body length 102 mm., tail 86, hind foot 25, ear 15.5, weight 38.5 grams, condylo-basal length 23.8 mm.

Specimens examined.—Thirty-three adult specimens were obtained in Mingulay, 30 of these were sexed (17♂, 13♀); 13 were caught in March, 17 in April, and 3 in June, 1938. In Berneray 8 adults were obtained in December, 1937; of the 6 examined all were males.

A series of 17 skins of adults (8♂, 9♀) is available from Mingulay. The type has fewer dark hairs above than some of these; but on the whole the series is very uniform in coloration. The pectoral spot is elongated and is obvious in nearly all specimens. In two females there is a suggestion of a buff suffusion on the tips of the belly hairs. Berneray mice resemble Mingulay mice except that the pectoral spot seems to be more prominent in the former. Some of the relative skull measurements compared with those of *A. h. hebridensis* (table 1) are summarized below:

	Mingulay	*Berneray*
Zygomatic breadth	less	less
Interorbital breadth	less	slightly less
Cranial depth (at middle)	much less	much less
Condyle to m^3	greater	slightly greater
Palatal foramina (length)	slightly longer	same
Palatal foramina (greatest width)	much wider	same
Masseteric plate (least width)	greater	greater

In addition to the above differences, casual inspection showed that the mesopterygoid fossa was distinctly narrower and more parallel-sided in these mice than in specimens from Barra and Lewis. The anterior margin of the fossa is more or less pointed, instead of being rounded or square, as is usually the case in *hebridensis* (fig. 1). Camera lucida drawings were made and measured at a magnification of 24 diameters. The following measurements were taken: length of the mesopterygoid fossa from the posterior margin of the palate to a point halfway between the hamular processes of the pterygoids; this length was then divided into four and the width of the fossa determined at each point.

Below is given the averages of the measurements of the four widths of the mesopterygoid fossa of mice from the three islands expressed as percentages of the length:

	width 1	*width 2*	*width 3*	*width 4*
Barra	27.1	29.6	32.9	51.8
Mingulay	23.8	23.9	26.9	47.5
Berneray	21.1	20.4	26.1	48.2

From these data and the figures given in table 1, it will be seen that in Mingulay and Berneray mice the mesopterygoid fossa is both relatively and actually distinctly longer and narrower than in Barra mice. For the first half of its length it is parallel-sided in

Mingulay mice, and converges instead of diverging in Berneray mice. The distance between the hamular processes is but little reduced in comparison. The short absolute length of the fossa in Barra mice is partly but not wholly accounted for by the smaller size of the specimens available from this island. Connected with this increased length of the fossa the length from the condyle to the posterior surface of the third molar is increased in Mingulay and Berneray as compared to Lewis mice (table 1); while the distance from the condyle to the front of the bulla remains the same.

The cranial differences noted above and the larger pre-orbital foramen in Mingulay mice are probably nearly all correlated with specially powerful masticatory muscles.

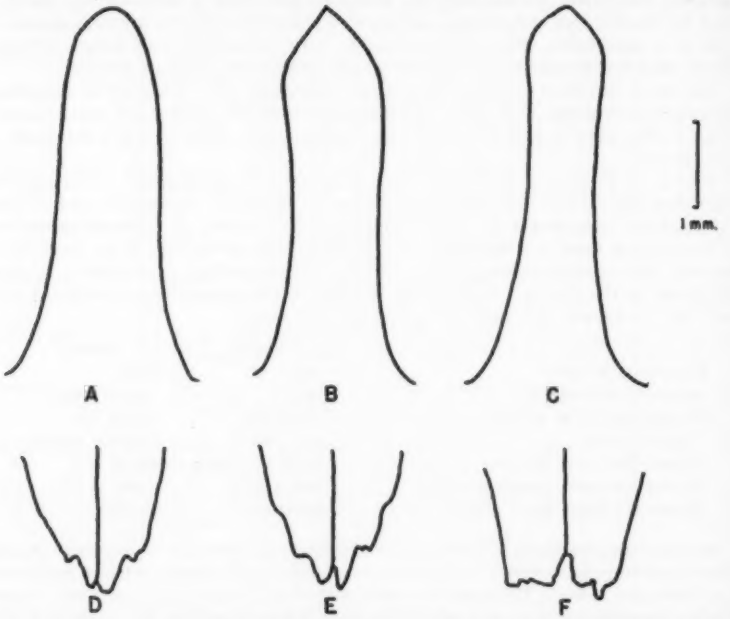

FIG. 1. The mesopterygoid fossa and the posterior end of the nasals in field mice from Barra (A and D), Mingulay (B and E), and Berneray (C and F).

The muscle origins on these skulls are well marked and in a Mingulay specimen taken in June the skull shows an incipient angularity which in other forms is seen only in *A. h. hamiltoni* Hinton, and *A. flavicollis wintoni* (Barrett-Hamilton). The long mesopterygoid fossa is no doubt due to the development of the internal pterygoid muscles. The pterygoid fossae in which these muscles originate are deeper and better marked than in Barra mice, and perhaps as a result of this the external pterygoid process is more distinct. In the lower jaw the inflected shelf of the angular process is slightly larger and some of the fibres of the internal pterygoid muscle are inserted on to it. Despite this muscularity the coronal length of the molar teeth is not increased.

In size these mice equal and sometimes exceed *A. h. hebridensis* from Barra and Lewis.

The relative lengths of tail, hind foot and ear are about as in the typical subspecies. The ear and hind foot are usually 16 mm. and 24–25 mm. in length, respectively.

Field mice are common on both Mingulay and Berneray. On Mingulay they live on the hillsides; their holes are easily found and so are the excavations they make to obtain grass roots. They are also found among the ruins of the crofts, and they occasionally enter the single inhabited house. The mice caught in April were fat; no female was pregnant.

Barra lies, with North Uist, South Uist, Benbecula, and Lewis, within the ten fathom line; but Mingulay and Berneray may have been isolated for a longer period as the channel separating them from the other islands is fifteen fathoms deep. Berneray and Mingulay mice are very similar. This is not surprising as the two islands are separated by a channel only half a mile wide and seven fathoms deep. There are, however, a few differences, some of which have already been mentioned. In addition, the bullae are somewhat smaller in Berneray than in Lewis or Mingulay specimens; and the nasals are squarely truncated posteriorly instead of being bluntly pointed as is usual (text fig. 1). Berneray more than Mingulay mice diverge in skull characters from the forms living on Lewis and Barra. The significant factor here is probably the small size of Berneray as compared to Mingulay, for the two islands have the same geological composition (Lewisian gneiss) and much the same topography and flora.

Examination of the extensive series of skulls of British *Apodemus* in the British Museum shows that occasionally *A. sylvaticus sylvaticus* may have a very narrow mesopterygoid fossa. Such specimens differ from the forms of Mingulay and Berneray in that the fossa is square in front; it is not as long, nor do the sides converge before subsequently diverging. Two specimens from the Scilly Isles, one from Hereford and one from Ballaghmoor, County Carlow show this type of narrow fossa. The converging of the sides of the mesopterygoid fossa to a point anteriorly is the main feature used to separate the St. Kilda house mouse *Mus muralis*, Barrett-Hamilton from the house mouse, *Mus musculus*.

I am grateful to Mr. T. C. S. Morrison-Scott of the British Museum (Natural History) for reading the manuscript and for advice; and also to Mr. D. MacLachlan of Berneray and Mr. R. McIntosh of Mingulay who kindly caught some specimens for me.

LITERATURE CITED

Baker, J. R. 1930. The breeding season in British wild mice, Proc. Zool. Soc. London, vol. i., p. 113.

Barrett-Hamilton, G. E. H., and M. A. C. Hinton. 1915. A History of British Mammals, Part xvii.

Hinton, M. A. C. 1914. On British forms of Apodemus, Ann. Mag. Nat. Hist., vol. 14, p. 117.

Warwick, T. 1938. Notes on mammals of the isles of Barra, Mingulay, and Berneray, Outer Hebrides. Scottish Nat., no. 230, pp. 57–59.

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THE INSECTIVOROUS BATS COLLECTED BY H. C. RAVEN IN CELEBES

By H. Harold Shamel

The Celebean insectivorous bats described in this paper were given to the United States National Museum by the late Doctor W. L. Abbott. Collected by H. C. Raven, in the years 1916–1918, they represent, perhaps, the largest collection of bats from Celebes ever to be reported on at one time. The 13 forms represented are as follows:

Megaderma spasma celebensis subsp. nov.

Type.—Adult male, skin and skull, no. 216945, U. S. National Museum, collected at Likoepang, Celebes, February 26, 1916, by H. C. Raven.

Geographic distribution.—Celebes.

Diagnostic characters.—Skull smaller than *M. spasma spasma* from the Philippines, greatest length of skull, 24.8–25.0 as against 25.6–26.0 in 7 skulls from Celebes and 10 skulls from the Philippines. Color of back and belly not sharply contrasted as in the Philippine animal.

Color.—The color, when compared with that of skins from Luzon, is at once distinguishable. The back is browner. The gray bases of the hairs are so short that they can scarcely be seen from the surface, thus giving the back a more or less uniformly brown color, near bister brown (Ridgway, 1912). The under side is much the same color as the back, only a shade lighter. The Luzon bat has very little brown on the back, and the gray-blue underfur everywhere shows through, while the under side is a very light pinkish buff (Ridgway, 1912) in sharp contrast to the darker back.

Measurements.—Type: Head and body, 70.0; tibia, 28.2; foot, 17.0; forearm, 53.5; greatest length of skull, 25.0; condylobasal length, 21.5; interorbital constriction, 4.0; zygomatic breadth, 13.0; breadth of braincase, 10.5; maxillary toothrow, 9.0; mandibular toothrow, 10.0.

Specimens examined.—Fourteen: 3 skins with skulls (2 from Likoepang, nos. 216945–946; 1 from Pinedapa, no. 219345) 11 in alcohol, (1 from Manembo Nembo, no. 217526; 3 from Likoepang, nos. 217080–082; 7 from Pinedapa, nos. 219368–374).

Remarks.—Thanks to the loan of 11 skins and skulls of *Megaderma spasma spasma* collected recently by Barbara Lawrence for the Museum of Comparative Zoology I have been able to separate these two bats (*spasma* and *celebensis*) which Andersen regarded as identical (Andersen, Diagnoses of new Bats of the Families Rhinolophidae and Megadermitidae, Ann. Mag. Nat. Hist., ser. 9, no. 10, p. 383, October, 1918). With the aid of this series and two specimens in alcohol in the U. S. National Museum collection from the Philippines, a careful comparison was made. So far as the skin measurements are concerned there is very little difference in the two animals. The Philippine bat averages slightly larger in most of its measurements. The principal difference is in the color. The skull measurements, however, show that the skull of the Celebean bat is smaller in all its measurements except the width of the interorbital region, which is slightly greater.

Hipposideros gentilis toala subsp. nov.

Type.—Adult female in alcohol, no. 219390, U. S. National Museum, collected at Toeare, Celebes, September 16, 1917, by H. C. Raven.

Geographic distribution.—Celebes.

Comparisons.—Hipposideros gentilis toala is distinguished from *H. gentilis gentilis* by its smaller skull (condylobasal length 14.0–15.0 as against 15.0–15.5) and by its longer forearm (42.0–45.9 as against 38.5–41.5); from *H. gentilis sinensis* by its smaller skull (condylobasal length, 14.0–15.0 as against 15.7–16.3), shorter toothrow (c-m^3 6.0–6.0 as against 6.2–6.7) and longer forearm (42.6–45.8 as against 40.0–43.0); from *H. gentilis atrox* by its smaller skull and teeth (condylobasal length 14.0–15.0 as against 15.7–16.3, c-m^3 6.0–6.0 as against 6.2–6.7); from *H. gentilis major* by its smaller skull and teeth (condylobasal length 14.0–15.0 as against 16.0–16.7, c-m^3 6.0–6.0 as against 6.5–6.8).

Measurements.—Type: Head and body, 46.2; tail, 28.2; tibia, 17.0; foot, 8.0; forearm, 43.0; 3rd metacarpal, 32.0; thumb, 4.0; ear from meatus, 18.5; ear from crown, 13.0; breadth of ear, 15.5; Skull, greatest length, 17.2; condylobasal length, 15.0; zygomatic breadth, 7.8; interorbital breadth, 2.6; breadth of braincase, 7.0; depth of braincase, 6.2; maxillary toothrow, 6.0; mandibular toothrow, 6.0; anteorbital width, 4.6.

Specimens examined.—Twenty-one: 13 from Gimpoe or Bada (original labels lost in transit to Museum), nos. 219392–403, 219405; 3 from Gimpoe, nos. 219384–386; 5 from Toeare, nos. 219387–391. All specimens in alcohol.

Remarks.—This bat is one of the *bicolor* group, members of which are distinguished from all other forms of the genus *Hipposideros* that I have examined by the absence of supplementary nose leaves. I have seen specimens of *H. gentilis sinensis* from Fukien and *H. gentilis major* from Nias. Both these skulls are larger by actual comparison. The measurements for all others that I have quoted in my comparison have been taken from Andersen's paper.

Hipposideros pelingensis sp. nov.

Type.—Adult male, in alcohol, no. 219433, U. S. National Museum, collected on the Island of Peling, Celebes, May, 1918, by H. C. Raven.

Geographic distribution.—Island of Peling, East of Celebes.

Diagnostic characters.—Like *Hipposideros dinops* Andersen from Solomon Islands, except that it has a shorter tibia, 38.2–41.0 as against 44.0.

Skull.—I can see no differences in the measurements of the skull and those given by Andersen in his description of the type of *Hipposideros dinops*. The upper incisors are small and bicusped, their inner cusps larger than the outer ones. These cusps are more noticeable from a posterior view. Of the forms of *H. diadema* described in Andersen's paper "On Hipposideros diadema and its closest allies," I have seen the skulls of 9 *H. diadema griseus*, 15 *H. diadema vicarius* and 7 *H. diadema diadema*. *H. pelingensis* more nearly approaches *H. diadema diadema* in size than any of the others.

Besides these three new bats the Raven collection includes the following:

Myotis muricola amboinensis Peters. Type from the Island of Amboina. A large form of *M. muricola* known only from Celebes, Buru, Amboina, and Ceram. Specimens examined: 3 skins (nos. 217521–523) and 60 specimens in alcohol (nos. 217465–524) all from Temboan, and one specimen in alcohol from Toeare (no. 219411).

Myotis near muricola Hodgson. Type from Nepal, northern India. Specimens examined: 3 skins from Pinedapa (nos. 219353–355).

Pipistrellus abramus Temminck. Type from Nagasaki, Japan. Specimens examined: 3 specimens in alcohol, Pinedapa (no. 219412), Soemalata (no. 199835), Kirandang (no. 199836).

Pipistrellus petersi Meyer. Type from Minahassa, northern Celebes. Specimens examined: Six in alcohol, Toeare (nos. 219407, 219414) and 4 without definite localities, received without original labels, (nos. 219408–410, 219413).

Kerivoula hardwickii Horsfield. Type from Java. Specimens examined: 4 in alcohol,

Temboan (nos. 217524–525); Tomado (no. 219406); one without definite locality (no. 219415).

Emballonura monticola rivalis Thomas. Type from Borneo. Specimens examined: 57 specimens as follows: Limpoeang (nos. 217009–060); Island of Peling (nos. 219420–422); Teteamoet (no. 217008); Sungai Palelah (no. 199837).

Emballonura papuana Thomas. Type from Wakatimi, southwest Dutch New Guinea. Specimen examined: 1 in alcohol, Teteamoet (no. 217008).

Hipposideros diadema speculator Andersen. Type from Kalao, Celebes. Specimen examined: 1 skin, Pinedapa (no. 219356).

Hipposideros galeritus galeritus Cantor. Type from Pinana Island off the west coast of the Malay Peninsula. Specimens examined: 4 in alcohol, Peling Island (nos. 219423–425); Gimpoe or Bada (original label lost) (no. 219404).

Rhinolophus celebensis Andersen. Type from Makassa, southern Celebes. Specimens examined: 11 in alcohol, Pinedapa (nos. 219375–383); Temboan (nos. 217463–464).

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GENERAL NOTES

MYOTIS LUCIFUGUS PHASMA IN CALIFORNIA

In their original description of *Myotis lucifugus phasma*, Miller and Allen (Bull. U. S. Nat. Mus., 144, pp. 53–54, 1928) list only four specimens of this subspecies. Three of these were from Colorado, and the fourth was from the Argus Mountains, Inyo County, California. The specimen from the Argus Mountains was somewhat doubtfully referred to *phasma* because it was in poor pelage. No other specimens of this bat have, to my knowledge, been recorded from California.

That this subspecies occurs in California is now fully substantiated by eight specimens in the California Museum of Vertebrate Zoology taken on July 30, 1931, at Keeler, Inyo County, by George S. Swarth, Emma D. Benson, and me. The bats were found in the loading station of the Cerro Gordo mine. This station is on the railroad at the end of a bucket conveyor system that runs from high up on the west-facing slope of the Inyo Mountains. The bats were pulled out of cracks among the beams near the roof by means of a wire. Those that escaped took refuge in other recesses inaccessible to us, or flew out of the building into the bright sunshine. Large piles of droppings on the beams indicated a long residence in the building.

All the specimens were females; none contained embryos. All agreed with the original description in being pallid in color. They are remarkably pallid in comparison with specimens of *Myotis lucifugus carissima* from the Sierra Nevada a few miles to the west.—Seth B. Benson, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

THE HOARY BAT IN NEW JERSEY

Since but two New Jersey specimens of the hoary bat (*Lasiurus cinereus*) are recorded in the literature, it seems worth while to summarize the status of this handsome animal in this state, as much new data on this subject has now been brought to light. Following is a list of the known specimens taken to date.

One taken September 26, 1923, at Palmyra by B. J. Sim, of Trenton. Now no. 13065 in the collection of The Academy of Natural Sciences of Philadelphia.

One captured January 1, 1910, at Cape May by O. H. Brown for Dr. Witmer Stone.

No. 12747 in the catalogue of The Academy of Natural Sciences of Philadelphia and now in the collection of Dr. H. B. Sherman of Gainesville, Florida.

Dr. C. Hart Merriam in his paper "Do any Canadian Bats migrate? Evidence in the affirmative" (Proc. & Trans. Roy. Soc. Canada, for 1887, vol. 5, sect. 4, pp. 85-87), quotes a letter from C. B. Riker of South Orange as follows: "On September 10th., 1883, I captured one at Maplewood, New Jersey, hanging in a brush-lot, on a sumac bush; the specimen is now in my collection."

William Cooper (Annals Lyceum Nat. Hist. New York, vol. 4, p. 56, 1837), records under the name *Vespertilio pruinosus*, a hoary bat "shot by Mr. J. F. Ward, in the month of November, near the heights of Weehawken, in New Jersey, near this city, in broad daylight. . . . It is not improbable that it migrates hither from the north, Dr. Richardson having met with it in lat. 54°." This last is of interest in that it is probably the first reference to the migratory habits of this species. There is a specimen in the American Museum of Natural History (no. 1106, purchased in 1887 from the Lawrence Collection) labelled "in autumn resting on cornstalk West Hoboken, N. J." with no further data. Professor Oliver P. Medsger of the Pennsylvania State College writes me that on October 23, 1909, he collected two hoary bats, both males, on Little Snake Hill, a small hill of igneous origin rising out of the Hackensack River marshes. The bats were clinging to the bark of rock chestnut oaks (*Quercus prinus*) about five feet above the ground; these were mounted for the Dickenson High School in Jersey City.

On September 25, 1938, I took a male hoary bat near the end of the road which runs from Tuckerton, seven miles southeast across the salt marsh to the water opposite Beach Haven Inlet. The bat was found hanging head down in a small (five foot) bayberry bush (*Myrica carolinensis*) about 150 yards from the bay. A female red bat (*Lasiurus borealis*) was found hanging in a smaller bayberry bush about fifty yards from the water. The previous night there had been a strong northwest wind, which had blown many migrating land birds to the coast, both at the end of the Tuckerton road and at Holgate, where three bats, one of which was identified as a red bat, were seen flying about between 6:45 and 9:30 a.m. the same day. Both bats taken were fat and in good condition; they are in my possession.

The hoary bat has been found in New Jersey most commonly as a fall transient, occurring from September 10th to November.

It must winter also, at least in small numbers, in the southern part of the state, as shown by the Cape May record mentioned above; and although it was formerly thought that this species did not pass the breeding season in this state, Earl L. Poole's record of its breeding in southeastern Pennsylvania (Jour. Mamm., vol. 19, p. 249, 1938) indicates that it may be looked for in summer in the mountains of northwestern New Jersey.

The paucity of fall records and the apparent lack of spring data make it impossible to determine the migration routes. However, bats have been observed in the fall, flying south along the first Watchung Mountain at Montclair, New Jersey, following a migration route regularly used by hawks and other birds. Other records show that some individuals use the Delaware Valley, while perhaps the majority follow the coast. In spring, the lack of records, even from the coast, where the bats would be most readily noted, makes it seem likely that the inland routes are taken by the majority of individuals at this season. However, much more data than is now available must be collected before such hypotheses can be proved.

The writer is much indebted to Prof. Oliver P. Medsger of the Pennsylvania State College, Mr. T. Donald Carter of the American Museum of Natural History, and Mr. Fred A. Ulmer, Jr. of the Academy of Natural Sciences of Philadelphia for assistance in compiling the records used in this note.—Robert W. Storer, *South Orange, New Jersey.*

THE POCKETED BAT IN CALIFORNIA

Grinnell wrote in 1933 (Univ. Calif. Publ. Zool., vol. 40, p. 95) that three specimens of *Tadarida femorosacca* had been collected in California. The type specimen was shot at Palm Springs, Riverside County, and another was found impaled on a mesquite bush at the same locality. He cited Shamel (Proc. U. S. Nat. Mus., vol. 78, p. 13, 1931) as authority for the statement that a third specimen was obtained in California at "Colorado River mouth". In his list of external measurements of *Tadarida femorosacca*, however, Shamel (p. 22) mentions a specimen from "Mexico: Colorado River mouth", probably the same bat as the one referred to on page 13. At my request Mr. A. H. Howell has looked up this specimen in the National Museum. He finds that the ascription of this third specimen to California was an error since the specimen really was obtained at the mouth of the Colorado River in Mexico. Therefore the two specimens from Palm Springs furnish the only valid published records from California.

A third Californian specimen of this species has, however, now been collected. Philip Krutzsch and I took it on May 7, 1939, at Palm Canyon, Borego Valley, San Diego County. It is now no. 90371 in the collection of the Museum of Vertebrate Zoology, University of California. This bat was the only one we were able to capture from a group in a crevice in a boulder on the west-facing slope of the canyon. The locality is about 35 miles south of Palm Springs. Both places are on the edge of the foothills bordering the western margin of the Colorado Desert.—RICHARD W. NEIL, *2618 College Avenue, Berkeley, California.*

A WEASEL ATTACKS A VARYING HARE

At 7 P. M. July 6, 1939, near my cabin on Lost River Reservation, New Hampshire, I found an apparently lifeless snowshoe hare (*Lepus americanus virginianus*), less than a month old, and a weasel that seemed little larger. As I stooped to examine the hare, the weasel circled excitedly about me, frequently coming within a few inches of my fingers, and occasionally pausing to examine me at a safe distance. The hare gasped wheezily, whereupon the weasel seized it by the side of the neck and dragged it away. When I followed too closely, the weasel dropped the hare.

The hare revived rapidly after being dropped the second time, at first dragging itself about by its front legs, then regaining the use of its hind legs. Finally I had to hold it by the scruff of the neck to prevent it from running away. I found that a little pressure of my fingers brought forth a gasping cry that invariably excited the weasel to run up very close to my hands.

Unfortunately, at this time another member of the party tried to club the weasel. The weasel became more cautious, but never ceased its rapid movements, though its circles were larger and at safer distances. It was reported that the weasel remained in the vicinity for some time, once climbing on a rock and "chirruping" at the onlookers.

The weasel had dragged the hare about fifty feet from the point where it was first seen. The hare seemed unharmed. It was kept alive by well-meaning individuals, but after twenty-four hours it died.—WALTER A. THURBER, *136 Linn Street, Ithaca, New York.*

TOXICITY OF POLAR BEAR LIVER

Poisoning from eating the liver of the polar bear has been mentioned by many arctic travelers. Ernest Thompson Seton gives a summary of several accounts in his "Lives of Game Animals," vol. 2, part 1, pages 203–204. These various experiences should be sufficiently impressive to leave no doubt in the minds of all travelers in the north; but it seems that there still exists some question about the matter, and some arctic travelers are not aware of the effects to be expected from such indulgence.

In August, 1938, Mr. and Mrs. Lawrence C. Woods, Jr. and Colonel Paul C. Hunt chartered a power boat at Moose Factory; accompanied by Mrs. Twomey and Mrs. Doutt, they joined the Carnegie Museum party on the Belcher Islands, where Dr. A. C. Twomey and I had spent the summer studying the mammals and birds of the region. After collecting a group of walrus on the Sleeper Islands for a habitat group at the Museum, we all proceeded southward to Walter Island, where Mr. Woods and Colonel Hunt collected two specimens of polar bears for the Museum. The two bears were killed on the evening of September 8, and that same evening the entrails were removed and the bears were lowered into the water for cooling and cleaning. Early the next morning they were hauled aboard and we continued to Charlton Island where we anchored that evening. Someone thought it would be nice to have polar-bear steaks for dinner, but the bears had not been skinned. The heart and liver had been saved, however, so we compromised on fried liver and onions. The cook prepared a large serving for each of us. The first taste was slightly soapy, but after that the meat seemed delicious and we ate heartily of it. I had two slices, each about 3 by 5 by ½ inches. All went well until about one o'clock the following morning. I wakened then with a start. There was a dull ache in my head and I was uncomfortably sick at my stomach. Through my mind flashed the unhappy thought—polar bear liver; why, of course, it's poisonous! Why hadn't I thought of that before dinner? For a long time I lay in my bunk debating whether or not I should rouse the party and give each of them an emetic, but, as I had never heard of a death from the effects of polar bear liver, I decided that to wake the others and tell them they had been poisoned might be worse than the poison itself. Robbie Linklater, Alex Hunter and Jimmie Chum, who made up the crew, had all been born and raised in the James Bay region, and not one of them had heard of the poisonous effects of polar bear liver. They had eaten as heartily of it has had the rest of us.

The next morning all of us were sick, those who had eaten most heavily being the most affected. Violent headaches, nausea, a sensation of dizziness and torpor overtook us. Those who partook liberally of laxatives seemed to improve more rapidly than those who did not. Although none of us experienced the peeling of the skin mentioned by some arctic travelers, it was two or three days before we were again feeling normal.—J. Kenneth Doutt, *Carnegie Museum, Pittsburgh, Pennsylvania.*

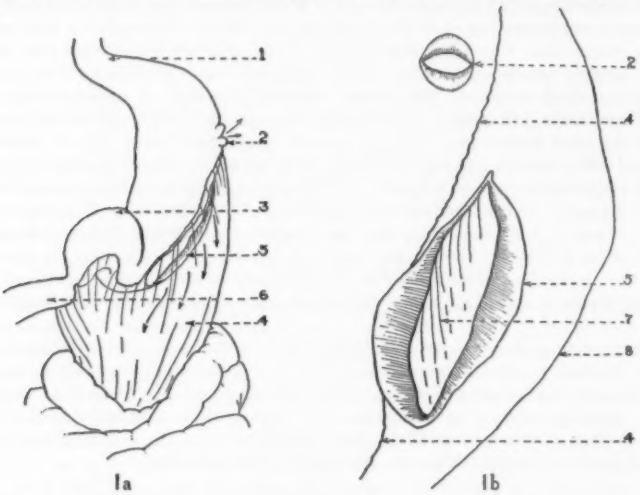
A SEA OTTER WITH GASTRIC PERFORATIONS

In December of 1939 a sea otter, *Enhydra lutris nereis*, was found dead on one of the beaches south of Carmel, Monterey Co., California. This animal was a subadult male. The body was examined carefully for any sign of external injury but none could be found. When skinned, the body was preserved in formaldehyde.

On opening the abdominal cavity to insure a better fixation and also with a hope of determining more accurately the cause of death, I found that two holes, a small and a large one, had formed in the wall of the stomach. The anterior and smaller hole is about 3½ inches behind the esophageal end of the stomach. It opens directly into the dorso-lateral part of the peritoneal cavity, ventral to the greater omentum (fig. 1a). This hole is 1.5 cm. in diameter across the slit and almost 2.0 cm. in diameter across the lips, by which it is surrounded. The slit extends in a dorso-ventral direction and transverse to the long axis of the stomach. The lips are formed by what appears to be the inner surface rolled outward, over, and under. The edges are smooth, as though well healed. The lips rise well above the outer surface of the stomach wall. This opening would permit the passage of small pieces of food material from the stomach into the greater peritoneal sac; nevertheless a small amount of blood seemed to be the only material free in this region.

The second hole is large and located about an inch posterior to the first. It extends along the greater curvature for approximately 3¼ inches—almost into the pyloric region of the stomach. This opening is longitudinal to the long axis, whereas the other hole is transverse. The left or dorso-caudal wall of this hole is turned out and greatly thickened, but not rolled. Its margin is perfectly smooth. The right or ventro-cranial wall is turned outward; it is thinner than the other and is rolled over and under. Here also the edge is smooth along the entire side. The ventral wall of the greater omentum attaches along the ventro-cranial margin of this hole a very short distance from the edge (fig. 1b).

This second hole permitted the contents of the stomach to pass directly into the lesser peritoneal sac or omental bursa (fig. 1a). The animal had evidently continued



1a 1b

FIG. 1a. Diagram showing general proportions; arrows indicate passage of food into coelom at 2, and omental bursa at 5.

FIG. 1b. Diagram of the two holes in the stomach wall. × ½. 1. Cardiac region of stomach. 2. Smaller hole, transverse to long axis. 3. Pyloric region of stomach forms a ventral loop. 4. Greater omentum. 5. Larger hole, opens into sac of greater omentum. 6. Duodenum. 7. Rugae within the stomach. 8. Dorsal side of stomach.

to eat as usual in spite of these holes in his stomach. As a result the omental bursa was completely filled with material of several kinds tightly packed into every available pocket. The well-filled greater omentum hung down into the abdominal cavity among the mass of small intestines. The thin-walled omentum, packed so tightly with all types of food, withstood the constant strain of the otter's activity, the presence of small pieces of crab shell and sea urchin tests, and also the presence of the gastric juices poured into this accumulating mass. Approximately one half gallon of food material was removed from this sac and then not all of the small particles were saved, for a considerable amount of the finer material adhered to the walls of the omentum and some particles were washed away. It was evident that some of the food had been in the sac for a long time.

The food materials so far identified are abalone, probably both red and black (*Haliotis rufescens* Swainson and *Haliotis cracherodii* Leach), rock crab, *Cancer antennarius* Stimpson, and the sea urchin, probably *Strongylocentrotus purpuratus* (Stimpson). I am indebted to Dr. Rolf Bolin and Dr. Heath of Stanford University for the identification of part of the food mass.—EDNA M. FISHER, *2410 Fulton St., Berkeley, California.*

BEAVER KILLED BY COYOTES

On February 19, 1940, Mr. T. F. Henshaw, of Denver, Colorado told Chief Ranger J. Barton Herschler, Rocky Mountain National Park, of a still warm carcass of a beaver (*Castor canadensis concisor*) he had found in the park the previous day on the ice covering the Thompson River. A coyote and several ravens deserted the carcass at his approach; and, from the signs in the snow, he believed that coyotes had killed the beaver.

Mr. Herschler, Park Naturalist Raymond H. Gregg, and I visited the place on February 20. By that time, the remains had been almost completely eaten; but the tracks provided the details of an interesting story. The beaver, a large adult, had come out of the river on the snow-covered ice about half a mile above the place where later it was killed. Proceeding a few hundred feet downstream, it returned to the water through a hole in the ice, but climbed out again a short distance below. From this point down, its tracks wandered along the middle course for a quarter of a mile; then it had turned suddenly to a rock on one side, and crossed to a shallow cavity under an alder on the opposite bank, apparently seeking a way to get back into the water. Failing in these attempts, the beaver continued downstream a few hundred yards, then doubled back, finding an old burrow in the exposed bank. Unfortunately, this tunnel extended only three feet into the bank, affording inadequate protection from two or three coyotes that came out of the woods from the south, descending the bank to the ice opposite the place where the beaver was hiding. They must have found the beaver sign almost at once, for they wasted no time following the trail downstream. They dragged the beaver from its shelter, some earth being loosened in the struggle, and killed it twenty feet away. There was little blood or fur on the ice, except at one place where some of the vital organs had become frozen into the trampled snow. Probably the beaver's resistance was relatively short. The snow nearby was much disturbed, probably by the coyotes when wrangling over the carcass.

A single line of very fresh coyote tracks proceeded upstream beside the downward path of the beaver. These tracks were clear, and did not attract our attention especially until suddenly some marks beside the pad prints showed that the coyote was dragging something which he had been carrying off the ground to this point. A short distance upstream, the coyote turned up the south bank, dropped his burden, which proved to be the torn skin of the beaver, and ran over the hill. The freshness of the tracks made it probable that this coyote had dropped the skin just a few moments before, when he heard our approach. Beside several tears in the skin, the head was missing, and there were three gashes in the tail.

Summer wanderings of beaver have been widely reported, but how often one might be found on land in winter is problematical. Possibly the apparent over-population of beaver that exists in this park caused this individual to wander downstream, or some other factor may have stimulated the action. Normally, beavers are probably little subjected to predation here. The trappers operating under the Colorado Game and Fish Department believe that coyotes rank first among the species that prey on beaver in this state; it is only when such suitable opportunities occur as were provided in this case that they can do so. Seton gives no instances of such predation, nor are any reported by Grinnell, Dixon and Linsdale for the California beaver. Warren (The

Beaver: its Work and Ways, Monog. Amer. Soc. Mamm., no. 2, 1927, p. 149) records one case in this park some years ago; Enos Mills (in Beaver World, 1913, pp. 25, 102, 161) gives several instances where a number of beavers were killed by coyotes.—Fred Mallery Packard, *National Park Service, Rocky Mountain National Park, Colorado.*

THE CANADA PORCUPINE AS A HIGHWAY CASUALTY

On September 23, 1939, while traveling east on State Highway 17 near the village of Peakville, Delaware County, New York, I found the carcass of a Canada porcupine (*Erethizon dorsatum*) lying on the cement road. Apparently the animal had been struck by a passing motor car within the preceding 48 hours. The body was badly crushed and two crows were feeding on the carcass just before I reached it.

This is the first time in more than 160,000 miles of automobile travel that I have been able to report one of these phlegmatic rodents as a motor car casualty; and, so far as I can ascertain, this constitutes the first published record for such a casualty in New York State.

As a matter of fact, on checking over the available literature—more than 60 titles—relating to mammalian (exclusive of human) motor car casualties on the highway, I find the porcupine listed only once. Dwight W. Davis (Jour. Mamm., vol. 14, pp. 76–77, 1933) reports the discovery of a female killed by an automobile April 19, 1932, near Barrington, Lake County, Illinois. Although the animal may have been an escaped captive this was, according to Mr. Davis, the first authentic record of the occurrence of the Canada porcupine in northern Illinois.

In view of the paucity of available data on the subject, I transmitted an informal inquiry to fourteen correspondents in various parts of New York State, some of whom had previously published notes or other information on wildlife highway mortality. Of the thirteen who replied, all but one had seen dead porcupines in the highway but only eight of the observers had kept definite records of their findings.

One correspondent wrote that in traveling over several thousand miles of roads through porcupine habitat in New York, other states and Canada he had observed no porcupine victims of the motor car. Another informant replied that his observation over a 10-year period did not include a single record of a porcupine casualty on the highway, while still another asserted that in more than 30 years of driving he had not encountered such a casualty. However, he volunteered the further information that within the past five years a neighbor had run over a porcupine with his automobile with the result that the quills of the animal penetrated two new tires and tubes and damaged them beyond repair.

Supplementing my own observation are the results of my inquiry which enable me now to report for the first time the following occurrences of Canada porcupine motor car casualties on New York State highways: Allegany State Park, Cattaraugus County, at least one each summer, 1936 to 1939; Au Sable Forks, Clinton County, one, November 16, 1939; Delaware County, one, May 26, 1932; Paradox Lake and other points in Essex County, four, April 13, 14 and 18, 1931 and August, 1937; Tupper Lake, Franklin County, one, autumn of 1939; Inlet and other points in Hamilton County, three, April 30 and May 6, 1930 and October 15, 1939; Old Forge and McKeever, Herkimer County, three, August 22, 1931, October 15 and 28, 1939; Canton and Edwards, St. Lawrence County, three, June 9, 1938 and autumn of 1939 (2); Wurtsboro, Sullivan County, one, October 14, 1939; Winnisook, and other points in Ulster County, six, July 14 and 23, 1932, June 29, 1933, June 5 and 27, 1934 and July 14, 1937; Warrensburg, Warren County, one, June 10, 1939; Granville, Washington County, one, late summer of 1938.

The following additional records were reported: McKean County, Pennsylvania, one, September, 1939; Potter County, Pennsylvania, two, July, 1931; Wilton, New Hampshire, one, September 13, 1939; Dorset, Vermont, one, summer of 1938.

Acknowledgment is made to Messrs. J. L. Buys, W. A. Dence, Allen Frost, W. J. Hamilton, Jr., G. R. La Plante, D. W. Mason, A. R. Shadle and C. J. Spiker, who have contributed to these records.

By way of emphasizing my own opinion as well as reiterating the one expressed by other observers, I may remark that wildlife highway casualties often furnish important clues to the local occurrence, abundance and distribution of many kinds of animals. It will be noted, for example, that at least 30 of the Canada porcupine fatalities herein reported are from 12 counties in New York State. Every reasonable effort should be made, therefore, to utilize to best advantage all records and specimens of wildlife thus sacrificed under the "wheels of progress."—DAYTON STONER, *New York State Museum, Albany, New York.*

CHEEK POUCHES OF THE PACA

For a considerable number of years I have speculated on the reason for the immense development in the paca (*Cuniculus*) of the zygomatic arch, which extends downward and backward uniquely as a broad, convex plate. Both jugal and maxilla (but not squamosal) are involved, and the lateral surface is extremely rugose.

Through the courtesy of Gerrit S. Miller, Jr., and the National Museum, I was recently given the intact head of a paca that had died in the National Zoological Park, and I immediately set about its dissection. I was somewhat disappointed to learn that the osteological peculiarity appeared to be correlated with no soft parts except the cheek pouches.

The temporal muscle in this animal is rather poorly developed, but the masseter muscle is immense. The insertion of the latter does spread over the expanded jugal, but it is difficult to see how this would be more effective than a more circumscribed insertion.

As mentioned by Pocock (Proc. Zool. Soc. London, 1922, p. 365) the paca has a pair of external and a pair of internal cheek pouches. The conformation of the latter justifies the present note. The external pouches are rather small and pass under the zygomatic arch, the bony inferior border of the zygomatic root of the maxillae forming the lateral margins of the pouches. These pouches are too small for the storage of food by an animal of such size and with feet that are utterly unsuited for filling cheek pouches. Hence it is probable that the external pouches were formed by the downward growth of the zygomatic arches and are in themselves of no primary use. The internal pouches, however, extend from the oral cavity into the relatively large chamber formed by the medial concave surface of the inflated maxillary root of the zygomatic arch. The walls of the internal pouch are attached to the neighboring bone by connective tissue in such fashion that the pouch is habitually held in a dilated position. Soft food could enter the pouch during mastication; but there is no muscular provision for emptying the pouch, and the animal could not accomplish this manually because of the bony covering. Hence, it seems likely that the internal pouch contains merely air (or at times possibly fluid). The pouch, however, can be emptied of such non-solid contents by a sucking action with mouth closed, during which the pouch will be collapsed by the encroachment of the medial wall of the *external* pouch. This could not be accomplished were there no external pouch. So it appears not unlikely that both the broad zygomatic arch and external cheek pouch are developments to facilitate the action of the internal cheek pouch.

The usefulness of this specialization is obscure. But one might call attention to the fact that these internal pouches constitute inflatable diverticula of the respiratory tract of the same general character as those that are present in some whales (Odontoceti) and pinnipeds (Phocidae), as well as the saiga and related antelopes (Saiginae).—A. BRAZIER HOWELL, *Johns Hopkins Medical School, Baltimore, Maryland.*

ESKIMO METHOD OF CAPTURING BOWHEAD WHALES

The following letter, addressed to Dr. Thomas Barbour and dated April 19, 1940, has been submitted for publication:

As a zoologist I think you will be interested in this biggest of all "fish" stories. I have been at Tigara (Point Hope) on the Arctic coast since January, doing a culture-contact study in this village. There are 250 Eskimos and their chief interest is whaling. Eight crews (about 50 men) began the yearly hunt last week. It will last until the 10th of June. I joined the crew of Unigluh as a paddler and have chased whales around ice floes for seven days now—so excited and so scared I can hardly sleep. There are eight of us in a crew and we have a 25 foot skin boat propelled only by paddles. The harpooner sits in the bow with a harpoon "darting gun" which he hurls by hand (there is a small bomb in the nose), and a regular 1860 "shoulder gun." We have to ride right up on top of the whales to make a successful strike.

This is what happens. A few days ago our boat struck a whale in a narrow lead in the ice pack. The bomb in the harpoon nose did not explode but the whale dove off into mush ice, towing a seal skin float and trailing quite a bit of blood. We went after him, forcing a way through the ice or pulling our boat over hard places. Finally we found our whale rolling about in a pond he had lashed out in the mush ice. We drove the boat right up on his back and our harpooner drove the harpoon into his neck. Our bomb didn't explode either—but the whale heaved up in the air flicking his flukes high in the air and hurling our boat clear of the water. We landed right side up but some of us nearly overboard. Then a third boat arrived, harpooned him (bomb exploded that time), and then backed off. I hopped out on an ice pan and photographed the kill right at the whale's nose. The three boats drove in and several Eskimos jabbed him with large cutting spades. He spouted blood in geysers all over us. We towed him back to what we thought was solid ice but the next day the wind changed and carried most of him off into the Arctic Ocean with a couple of dogs and some hunting gear. We all got ashore safely but after a lot of hard work.

We have killed three so far. There are scores of them, all bowhead, and hundreds of beluga which at this time the Eskimos don't bother with. Yesterday one Eskimo carelessly loaded his shoulder gun and the bomb exploded in the barrel. The barrel burst and he got part of it in his guts. He died this morning. This afternoon another shoulder gun exploded and another Eskimo got part of it in his leg; then this evening two darting guns exploded but hurt no one. I can't figure out what is going on but gather that shells and bombs for these guns that were used in the 1800's are hard to get and home made bombs really don't work very well. Today we had one whale swim around our boat watching us with one of those great big eyes, dive under us, and come up at the stern so we couldn't hit him. Another sank right under the boat an instant before the harpoon was thrown. The number is simply unbelievable. We have seen at least 20 every day. Sometimes there are three together and then they seem to be playing. We got right in the middle of one of these games but could not get over top of any one even though they rose all around us.—FROELICH RAINEY, *Tigara, Alaska.*

RECENT LITERATURE

[Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters.]

ABBIE, A. A. A masticatory adaptation peculiar to some diprotodont marsupials. Proc. Zool. Soc. London, vol. 109, ser. B, Syst. and Morphol., pt. 2, pp. 261–279, figs. 9. August, 1939.

ADAMS, LOWELL. Sierra chickaree eats young blue-fronted jays. Yosemite Nat. Notes, Stockton, vol. 18, no. 8, p. 93. August, 1939.

ALEKSEEV, A. On a new deer species from the Tertiary beds of Mongolia. Priroda, Leningrad, no. 11, pp. 96–98, figs. 3. 1937. (Review of Colbert, 1936, on *Stephanocemas thomsoni*. In Russian.)

ALIKHAN, IFTIKHAR. Method adopted by leopards in hunting monkeys. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, pp. 555–557. December, 1938.

ALLEN, DURWARD L. Swan Creek Wildlife Experiment Station. Michigan Conservation, Lansing, vol. 8, no. 10, pp. 8–9, 11. June, 1939.

——— Winter habits of Michigan skunks. Jour. Wildlife Management, Menasha, vol. 3, no. 3, pp. 212–228, pls. 7–10. July, 1939.

ANDERSON, R. M. (Review). A faunal investigation of western Rainy River District, Ontario, by L. L. Snyder. Trans. Roy. Canadian Inst., vol. 22, pt. 1, 1938. Published under The Reuben Wells Leonard Bequest. Toronto, 1938, pp. 157–213, 1 map. Canadian Field Naturalist, Ottawa, vol. 53, no. 7, p. 110. 1939.

ANONYMOUS. Beaver thriving in nine counties [Virginia]. Virginia Wildlife, Blacksburg, vol. 1, no. 3, pp. 1, 7. November, 1937.

——— Beaver colonies spreading. Virginia Wildlife, Blacksburg, vol. 2, no. 8, p. 3. April, 1939.

——— Game in Uganda. Intelligence of elephants. Indian Wild Life, Agra, vol. 4, no. 2, pp. 101–102. April–June, 1939.

——— Chicken-eating deer. Virginia Wildlife, Blacksburg, vol. 2, no. 10, p. 4. June, 1939.

——— Our Haitian Solenodon prospecting for insects in an old stump. New York Zool. Soc. School News, New York, vol. 4, no. 2, pp. 1–2, photo. June, 1939.

——— A survey of the annual fur catch of the United States. U. S. Bur. Biol. Surv., Wildlife Research and Management Leaflet BS-140, pp. 19, tables. June, 1939.

——— Lawful to engage in muskrat farming. North Dakota Outdoors, Bismarck, vol. 2, no. 1, p. 11. July, 1939.

——— Reindeer herd increasing. Nature Notes, Peoria, Ill., vol. 6, no. 7, p. 149. July, 1939.

——— Rocky Mountain mule deer *Odocoileus hemionus*. Wyoming Wild Life, Cheyenne, vol. 4, no. 7, pp. 4, 15, illus. July, 1939.

——— Pronghorn antelope *Antilocapra americana*. Wyoming Wild Life, Cheyenne, vol. 4, no. 8, pp. 6, 17. August, 1939.

——— Raising deer in captivity. U. S. Bur. Biol. Surv., Wildlife Leaflet BS-144, pp. 1–6. August, 1939.

——— Strange contents of elephants' stomachs. Jour. Soc. Preservation Fauna of the Empire, Hertford, n. s., pt. 37, p. 48. August, 1939. (Pebbles and stones eaten. Stone 10 inches in diameter and weighing 15–20 lbs. found in stomach of elephant shot in Toro District, Uganda, Africa.)

ANONYMOUS. Big-game inventory of the United States, 1938. U. S. Bur. Biol. Surv., Wild-life Leaflet BS-142, pp. 11, tables 17. August, 1939.

——— Most perfect Neandertal skull is being studied in Rome. Science News Letter, Washington, D. C., vol. 36, no. 7, p. 108, illus. August 12, 1939.

ANTHONY, H. E. The horns. The Sportsman, Concord, N. H., vol. 13, no. 3, pp. 33, 62, illus. March, 1933. (Bighorns.)

ARGYROPULO, A. I. *Sciuromorpha* and *Dipodidae* (Glires, Mammalia) in the Tertiary of Kazakhstan. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 25, no. 2, pp. 171–175, figs. 2. 1939. (New: *Protaalactaga borissiaki*.)

——— Remains of a beaver (*Amblycastor caucasicus* sp. n.) from the Pliocene of the Ciscaucasia. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 25, no. 7, pp. 636–639, illus. 1939. (New: *Amblycastor caucasicus*.)

ASTRE, GASTON. Faune des steppes froides à Spermophile et climats du Pléistocène supérieur aux Pyrénées. Bull. Soc. Géol. France, Paris, ser. 5, vol. 7, nos. 1–3, pp. 59–68, figs. 2. 1937.

AYER, MARY Y. What do you know about: The sea otter. Frontiers, Philadelphia, vol. 3, no. 1, pp. 24–26, illus. October, 1938.

BACHKIROFF, I. Éléments composant les reliques (survivants) de la faune des monts Gigouli. Bull. Soc. Nat. Moscou, sect. biol., n. s., vol. 44, no. 5, pp. 240–245. 1935. (In Russian, with French résumé. *Spalax*.)

BAILEY, F. M. Occurrence of tiger in Sikkim. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 166. 1939.

BAILEY, VERNON. Habits of lowly cottontail described by dean of wildlife specialists. Virginia Wildlife, Blacksburg, vol. 1, no. 10, p. 7. June, 1938.

——— Coyote fur. Pennsylvania Game News, New Cumberland, vol. 10, no. 3, pp 12, 32. June, 1939.

BAILLIE, JAMES L. In birdland. Evening Telegram, Toronto, Ontario. June 3, 1939. (A few mammal records.)

BARABASCH-NIKIFOROW, J. J. Zur Tier und Vogelfauna des Tobolskschen Distrikts. Uchenye zapiski Saratovskogo gosudarstvennogo universiteta imeni N. G. Chernyshevskogo, Saratov, vol. 1, no. 14, biol. ser., pp. 107–133, figs. 6, tables. 1937. (In Russian, with German summary.)

BARBOUR, ERWIN HINCKLEY, and C. BERTRAND SCHULTZ. A new giant camel *Gigantocamelus fricki*, gen. et sp. nov. Bull. Univ. Nebraska, State Mus., Lincoln, vol. 2, no. 2, pp 17–27, figs. 5–12. September 1939. (New: *Gigantocamelus fricki*.)

BARKER, ELLIOTT S. Disappearance of bighorns a mystery. New Mexico Magazine, Santa Fe, vol. 17, no. 7, pp. 27–28. July, 1939.

BARROWS, E. F. Selection for tail spotting in the house mouse. Jour. Exper. Zool., Philadelphia, vol. 80, no. 1, pp. 107–111. February 5, 1939.

BARWICK, ARTHUR R. Miocene porpoise (*Delphinodon dividum*) from southern Maryland. Amer. Midland Naturalist, Notre Dame, vol. 22, no. 1, pp. 154–159, illus. July, 1939.

BATTYE, R. K. M. Occurrence of tiger in Sikkim. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 165–166. 1939.

BAUMGARTNER, LEONA. Root of our family tree. Collier's, New York, vol. 104, no. 12, pp. 22, 28, illus. September 16, 1939. (*Tarsius*.)

BAUMGARTNER, LUTHER L., and A. C. MARTIN. Plant histology as an aid in squirrel food-habit studies. Jour. Wildlife Management, Menasha, vol. 3, no. 3, pp. 266–268, pls. 14–17. July, 1939.

BEAL, WILLIAM P. B. The manatee as a food animal. Nigerian Field, London, vol. 8, no. 3, pp. 124–126. July, 1939.

Beaux, Oscar de. Una nuova sottospecie di *Vulpes rüppelli* in Libia. Ann. Mus. Libico Storia Nat., Tripoli, vol. 1, pp. 393–396, pl. 18. 1939. (New: *Vulpes rüppelli cufrana.*)

Bell, Frank T. Bureau of Fisheries. Annual Report of the Secretary of Commerce, 1937, pp. 83–106.

Below, Joachim. Die Nerzfarm Magdalenenlust im Kulturfilm. Deutsche Pelztierzüchter, München, vol. 14, nos. 13–14, pp. 289–293. July, 1939.

Benchley, Belle J. Marmosets. Zoonooz, Zool. Soc. San Diego, vol. 11, no. 6, pp. 4–6. June, 1939.

Benson, Seth B. New subspecies of the canyon mouse (*Peromyscus crinitus*) from Sonora, Mexico. Proc. Biol. Soc. Washington, vol. 53, pp. 1–4. February 16, 1940. (New: *Peromyscus crinitus delgadilli, P. c. rupicolus, P. c. scopulorum.*)

Bickel, Edmund. Sumpfbiberzucht in Schweden. Deutsche Pelztierzuchter, München, vol. 14, nos. 13–14, pp. 297–301. July, 1939.

Bien, M. N., and L. P. Chia. Cave and rock-shelter deposits in Yunnan. Bull. Geol. Soc. China, Chungking, vol. 18, nos. 3–4, pp. 325–347, figs. 12, pl. 1. December, 1938. (Fossil mammals.)

Blair, John. [Bushcow]. Nigerian Field, London, vol. 8, no. 3, p. 132. July, 1939.

Blair, W. Frank. Faunal relationships and geographic distribution of mammals in Oklahoma. Amer. Midland Naturalist, Notre Dame, vol. 22, no. 1, pp. 85–133, fig. 1, tables 2. July, 1939.

Blanc, A. C. Una serie di nouvi giacimenti pleistocenici e paleolitici in grotte litoranee del Monte Circeo. Atti. Reale Accad. Naz. Lincei, Roma, anno 335, ser. 6, Rendic. Cl. Sci. fische, mat. e nat., vol. 28, nos. 7–8, pp. 201–209, fig. 1. 1938.

Blanford, H. R. *Rhinoceros sondaicus* in Burma: The problem of conservation. Jour. Soc. Preservation Fauna of the Empire, Hertford, n. s., pt. 37, pp. 27–32. August, 1939.

Blunn, Cecil T. The age of rats at sexual maturity as determined by their genetic constitution. Anat. Record, Philadelphia, vol. 74, pp. 199–213. June 25, 1939.

Bogolyubsky, S. N. Comparative analysis of constitution of domestic and wild sheep. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 25, no. 3, pp. 253–257, 1 table. 1939.

Bond, Richard M. The care of skulls and skeletons of small animals. Science, Lancaster, n. s., vol. 89, no. 2310, p. 324. April 7, 1939.

———— Coyote food habits on the Lava Beds National Monument. Jour. Wildlife Management, Menasha, vol. 3, no. 3, pp. 180–198. July, 1939.

Bonin, Wilbrod, and Leonard F. Belanger. Sur la structure du poumon de *Delphinapterus leucas*. Trans. Roy. Soc. Canada, Ottawa, ser. 3, vol. 33, sec. 5, pp. 19–22. May, 1939.

Bourdelle, E. (Review of) Petit, Marcel, Anatomie des molaires des Equidés: Cheval et âne. Lion et fils, Toulouse, 1 vol., pp. 323, figs. 206, pls. 110. 1939. Mammalia, Paris, vol. 3, no. 2, pp. 80–81. June, 1939.

———— (Review of) Norman, J. R., et F. C. Fraser, Les Géants de la Mer (Requins,—Baleines.—Dauphins). Bibliothèque scientifique, Payot, Paris, 1 vol., pp. 426, figs. 97. 1938. Mammalia, Paris, vol. 3, no. 2, p. 81. June, 1939.

Bragg, Arthur N. Use of parentheses in zoological nomenclature. Science, Lancaster, n. s., vol. 89, no. 2321, p. 583. June 23, 1939.

Brambell, F. W. Rogers, and Kathleen Hall. Reproduction of the field vole, *Microtus agrestis hirtus* Bellamy. Proc. Zool. Soc. London, vol. 109, ser. A, Gen. and Exper., pts. 2–3, pp. 133–138, 1 table. July, 1939.

BRANCO, W. Descripcion de la fauna. Anal. Univ. Central Ecuador, Quito, publ. trimestral, vol. 61, no. 305, pp. 398–556. July–September, 1938. (*Edentata, Ungulata.*)

BRANDER, A. A. DUNBAR. Behaviour of monkeys when attacked. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 165. 1939.

BRESSOU, C., and G. VANDEL. Mensurations d'un éléphant d'Asie à la naissance. Mammalia, Paris, vol. 3, no. 2, pp. 49–52, pl. 3. June, 1939.

BREUIL, HENRI. Bone and antler industry of the Choukoutien Sinanthropus site. Palaeontologia Sinica, Peiping, new ser., D, no. 6 (whole ser., no. 117), pp. iv + 192, pls. 26. 1939.

BRIMLEY, C. S. A partial bibliography of North Carolina zoology. Jour. Elisha Mitchell Sci. Soc., Chapel Hill, N. C., vol. 54, no. 2, pp. 319–341. December, 1938.

BRITTON, S. W., and R. F. KLINE. On deslothing the sloth. Science, Lancaster, n. s., vol. 90, no. 2323, pp. 16–17. July 7, 1939.

BRONSON, WILFRED S. The chisel-tooth tribe. New York: Harcourt, Brace and Co., pp. [6] + 200, illus., pls. 4. 1939.

BROOM, R. The South African Pleistocene cercopithecid apes. Ann. Transvaal Mus., Cambridge, England, vol. 20, pt. 2, pp. 89–100, figs. 6. April 22, 1940. (New: *Parapapio whitei, P. jonesi, P. angusticeps, P. major.*)

BUDKER, PAUL. Sur la prétendue existence des Phoques dans la région de l'ile Shadwan (Mer Rouge). Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 11, no. 5, pp. 450–453. June, 1939. (The supposed seals were dugongs.)

BURCHELL, HOWARD B. Large vascular sinuses in the myocardium of a dog. Anat. Record, Philadelphia, vol. 74, pp. 195–197. June 25, 1939.

BURLINGAME, PAUL L., and J. A. LONG. The development of the heart in the rat. Univ. California, Publ. Zool., Berkeley, vol. 43, no. 12, pp. 249–320, pls. 26–52. 1939.

BURTON, R. G. Association between a leopard and a tigress. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 610. September 25, 1937.

BURTON, R. W. Unusual behaviour of panthers and tigers. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 167. 1939.

——— Hyaenas attacking human beings. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 170–171. 1939.

BUTLER, P. M. Studies of the mammalian dentition. Differentiation of the post-canine dentition. Proc. Zool. Soc. London, vol. 109, ser. B, pt. I, pp. 1–35. 1939.

C———, F. Field notes on oribi. Nigerian Field, London, vol. 7, no. 3, pp. 111–112. July, 1938.

——— Field notes on roan. Nigerian Field, London, vol. 8, no. 1, p. 10. January, 1939.

——— Field notes on white oryx. Nigerian Field, London, vol. 8, no. 1, pp. 10–11. January, 1939.

C., J. F. (Review). The Formenkreis theory and the progress of the organic world, by O. Kleinschmidt. Translated by F. C. R. Jourdain. London: H. F. and G. Witherby, pp. 192. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 163. 1939.

CABRERA, ANGEL. Estado actual de la cuestión del límite Cretáceo-Terciario en la Argentina desde el punto de vista paleontológico. Inst. Mus. Univ. Nac. La Plata, Obra del Cincuentenario, Buenos Aires, pp. 1–22. 1935. (New: *Brandmayria, B. simpsoni.*)

CABRERA, ANGEL. Notas sobre el suborden "Typotheria". pts. I–IV. Inst. Mus. Univ. Nac. La Plata, Notas del Museo de La Plata, Buenos Aires, vol. 2, Palaeont. no. 8, pp. 17–43, figs. 5. Febr. 25, 1937. (New: *Paedotherium minor, P. affine, Typotheriopsis silveyrai, Pseudotypotherium hystatum.*)

——— Sobre vertebrados fosiles del Plioceno de Adolfo Alsina. Rev. Mus. La Plata, Buenos Aires, n. s., vol. 2, sec. Paleont., pp. 3–35. April 10, 1939. (New: *Elassotherium, E. altirostre, Aspidocalyptus, A. castroi, Hoplophractus, H. tapinocephalus, Epecuenia, E. thoatherioides, Coscinocercus, C. marcalaini, C. brachyurus, Eoauchenia cingulata, Macrauchenidia, M. latidens.*)

CAHALANE, VICTOR H. The evolution of predator control policy in the National Parks. Jour. Wildlife Management, Menasha, vol. 3, no. 3, pp. 229–237. July, 1939.

CARTER, F. L. A study in jackrabbit shifts in range in western Kansas. Trans. Kansas Acad. Sci., Topeka, vol. 42, pp. 431–435, maps 4, tables. 1939. (*Lepus townsendii campanius* and *Lepus californicus melanotis.*)

CHAPPELLIER, A. Notes sur l'ecureuil. Les cachettes. Travaux de la Sta. Zool. de Wimereux, Paris, vol. 13, pp. 69–75, figs. 5. 1938.

CHAPPELLIER, ALBERT. Notes sur l'ecureuil. Bull. Soc. Nat. Acclimat. de France, Paris, vol. 86, nos. 3–4, pp. 88–101. April, 1939.

CHETWODE, D. A coin lodged in a tiger's palate. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 167–169. 1939.

CLARK, W. E. LE GROS. General features of the Swanscombe skull bones. Jour. Roy. Anthropol. Inst. Great Britain and Ireland, London, vol. 68, pp. 58–60, pls. 4–5. January–June, 1938.

——— The endocranial cast of the Swanscombe bones. Jour. Roy. Anthropol. Inst. Great Britain and Ireland, London, vol. 68, pp. 61–67, figs. 17–18. January–June, 1938.

——— The brain of the okapi. Proc. Zool. Soc. London, vol. 109, ser. B, Syst. and Morphol., pt. 2, pp. 153–159, figs. 4. August, 1939.

CLEMENTS, THOMAS. Age of the "Los Angeles Man" deposits. Amer. Jour. Sci., New Haven, ser. 5, vol. 36, no. 212, pp. 137–141. August, 1938. (Late Pleistocene.)

COLBERT, EDWIN H., and ROBERT G. CHAFFEE. A study of *Tetrameryx* and associated fossils from Papago Spring Cave, Sonoita, Arizona. Amer. Mus. Novitates, New York, no. 1034, pp. 21, figs. 12. June 26, 1939.

COLVILLE, ROBERT. A day with pure-bred otterhounds. Field, London, vol. 174, no. 4522, pp. 500–501, illus. August 26, 1939.

COUCH, LEO K. Review of cooperative wildlife management research. American Wildlife, Washington, D. C., vol. 28, no. 4, pp. 172–177. July–August, 1939.

COTTERELL, G. S. Duiker and francolin. Nigerian Field, London, vol. 7, no. 2, p. 95, illus. April, 1938.

COWAN, IAN MCTAGGART. The vertebrate fauna of the Peace River District of British Columbia. Occas. Papers British Columbia Provincial Mus., Victoria, no. 1, pp. 1–102, maps. 2, pls. 1–5. June 1, 1939. (Mammals, pp. 67–91.)

CREW, F. A. E. The arrangement of fibre follicles in some animals, with special reference to the Ovidae. Being selected and illustrated notes made by the late Dr. J. E. Duerden, emeritus professor of Rhodes University, Grahamstown; Honorary worker at the Wool Industries Research Association, Leeds, 1932–1937. Compiled by Dr. A. B. Wildman, Wool Industries Research Association. Trans. Roy. Soc. Edinburgh, vol. 59, pt. 3, sess. 1938–39, pp. 763–771, figs. 5, pls. 4. July 11, 1939.

DALQUEST, WALTER W. New meadow mouse from the San Juan Islands, Washington.

Murrelet, Seattle, vol. 21, no. 1, pp. 7–8. January–April, 1940. (New: *Microtus townsendii pugeti*.)

DAMMERMAN, K. W. On prehistoric mammals from South Celebes. Treubia, Buitenzorg, vol. 17, no. 1, pp. 63–72. 1939.

DANINI, E. S., and N. A. OLSCHWANG. Contributions to the ecology and biology of rodents of the Troitsk district, form. Ural province. 3. Notes on the anatomy and biology of *Cricetulus eversmanni* Br. Izvestiia biologicheskogo Nauchno-Issledovatel'skogo Instituta pri permskom gosudarstvennom Universitete, Perm (Bull. Inst. rech. biol. Perm), vol. 10, no. 3, pp. 114–124, figs. 9, tables 6. 1936. (In Russian, with English summary.)

DAVIS, PHILIP BRUCE. The fossil beds of Northwestern Nebraska as observed on the McPherson College 1937 summer biology trek. Trans. Kansas Acad. Sci., Topeka, vol. 41, pp. 199–200. 1938.

DEMIJASCHEW, M. Eine vervollkommnete Falle für Nager. Vestinik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidemiol., et Parasitol.), Saratov, vol. 12, no. 3, pp. 211–212, illus. 1934. (In Russian, with German summary.)

DEMPSEY, EDWARD W. The reproductive cycle of New World monkeys. Amer. Jour. Anat., Philadelphia, vol. 64, no. 3, pp. 381–406, figs. 2, pls. 1–4. May 15, 1939. (*Ateles geoffroyi* and *Alouatta palliata*.)

DETWILER, S. R. Comparative studies upon the eyes of nocturnal lemuroids, monkeys and man. Anat. Record, Philadelphia, vol. 74, pp. 129–145, 1 pl. June 25, 1939.

DEYSACH, L. J. The comparative morphology of the erectile tissue of the penis with especial emphasis on the probable mechanism of erection. Amer. Jour. Anat., Philadelphia, vol. 64, no. 1, pp. 111–131, 2 pls. January 15, 1939.

DIDIER, ROBERT, and PAUL RODE. Les Micromammifères de la Faune française. 1. Campagnols (suite). Mammalia, Paris, vol. 3, no. 2, pp. 59–75, figs. 10, pl. 5. June, 1939.

DUBROVSKII, A. N. On the nuptial cry of the bearded seal (*Erignathus barbatus* Fabr.). Priroda, Leningrad, no. 4, p. 124, illus. April, 1937. (In Russian.)

DULKEIT, G. D. On the biology of the sable and the sable farming on the island of Great Shantar. Bull. Pacific Sci. Fish. Res. Station, Vladivostok, vol. 3, pt. 3, pp. 1–120, illus. 1929. (In Russian, with English summary.)

DURNOVO, Z., A. MYTROFANOVA, M. SMOLJGOVSKAYA, I. KIRIS, and D. KIRIS. Changes in the fauna of pests in the podzol zone (Kirov region) in the case of virgin soil going into cultivation. Vsesoiuznaia akad. sel'skokhoziaistvennykh nauk imani V. I. Lenina, Vsesoiuznyi institut zashchity rastenii. Itogi (Summary Sci Research Work Inst. Plant Protect. for the year 1935), Leningrad, pp. 88–90. 1936.

DURYMANOVA-SAVIK, N. P. Contributions to the ecology and biology of rodents of the Troitsk district, form. Ural Province. 2. Some observations on the character of food of some rodents. Izvestiia biologicheskogo Nauchno-Issledovatel'skogo Instituta pri permskom gosudarstvennom Universitete, Perm (Bull. Inst. rech. biol. Perm), vol. 10, no. 3, pp. 101–113, tables 7. 1936. (In Russian, with English summary.)

DYBROUSKII, A. N. The sable [*Martes zibellina* (L.)] in the Yamal National District. Priroda, Leningrad, no. 9, pp. 88–90. 1937. (In Russian.)

DYMOND, J. R. Canadian conservation problems. Pt. 1. Bird-Lore, New York, vol. 41, no. 3, pp. 141–46. May–June, 1939.

——— Canadian conservation problems. Pt. 2. Bird-Lore, New York, vol. 41, no. 4, pp. 233–237. July–August, 1939.

EAST, BEN. Moose for tomorrow. Country Life, New York, vol. 76, no. 2, pp. 57, 88–91, illus. June, 1939. (Trapping of live moose on over-populated Isle Royale, Mich., to stock other regions.)

EDITOR. Pangolin and sambar: A curious belief. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 2, p. 322. September, 1938.

EHIK, JULIUS. Jackal or reed-wolf from Hungary. Annal. Mus. Nat. Hungarici 1937–38, Budapest, vol. 31, zool., pp. 11–15. 1938. (New: *Canis aureus hungaricus*. In Hungarian and English.)

EIPPER, PAUL. Menschen-Affen. Natur und Volk, Frankfurt a. M., vol. 68, no. 7, pp. 310–315, illus. July, 1938.

EISENTRAUT, M. Vom Wärmehaushalt der Fledermäuse. Natur und Volk, Frankfurt a. M., vol. 69, no. 5, pp. 223–233, illus. May 1, 1939.

ENDERS, ROBERT K., and OLIVER P. PEARSON. Three new rodent subspecies of *Scotinomys* from Chiriqui, Panama. Notulae Naturae, Philadelphia, no. 34, pp. 1–4. November 9, 1939. (New: *Scotinomys teguina episcopi, S. t. garichensis, S. t. leridensis*.)

ESKEY, C. R., and V. H. HAAS. Infection in rodents, experimental transmission by fleas, and inoculation tests for infection. Publ. Health Reports, vol. 54, no. 32, pp. 1467–1481. August 11, 1939. (Prairie dogs, marmots, chipmunks, wood rats, and various species of ground squirrels are involved in transmission of plague.)

ESTES, MILTON. The memoirs of Estes Park. Colorado State College Library, Fort Collins, Library Bull. 6, pp. 1–14. 1939. (Gives some early records of mammals.)

EVANS, FRANCIS GAYNOR. The morphology and functional evolution of the atlas-axis complex from fish to mammals. Ann. New York Acad. Sci., vol. 39, art. 2, pp. 29–104, figs. 15. June 13, 1939.

FENIUK, B. K., and M. P. DEMJASCHEW. Die Lebensdauer in der Natur von *Pallasiomys meridianus* Pall. (Mammalia). Vestnik Mikrobiol., Epidemiol. i Parazitol., (Rev. Microbiol., Epidemiol., et Parasitol.) Saratov, vol. 15, nos. 3–4, pp. 407–412, figs. 2, tables 4. 1936. (In Russian, with German summary.)

FENIUK, B. K., and M. V. SHEIKINA. Studies on the migrations of common-voles *Microtus arvalis* Pall. (Mammalia) by means of a ringing method. Abhandl. Tschernyschewsky-Staatsuniversität Saratov, vol. 1 (XIV), Biol. Ser., no. 2, pp. 85–102, figs. 2, tables 7. 1939. (In Russian with English summary.)

FERNANDEZ, MIGUEL. Uber Zelluntergang und sog. "Rundzellen" bei rudimentären Embryonen von *Tatusia hybrida* Desm. Vierteljahrsschrift Naturforsch. Gesell, Zürich, Jahrg. 83, Beiblatt, pp. 197–208, figs. 2, pl. 1. November 3, 1938.

FINDLAY, G. M., and F. O. MACCALLUM. Spontaneous yellow fever in rhesus monkeys in the absence of mosquitoes. Nature, London, vol. 144, no. 3642, p. 332. August 19, 1939.

FINLAYSON, H. H. On mammals from the Lake Eyre Basin. IV. The Monodelphia. Trans. Roy. Soc. South Australia, Adelaide, vol. 63, pt. 1, pp. 88–118, pls. 4–5. July 28, 1939.

FISHER, JAMES. The Zoo's new rodent house. The Listener, London, vol. 22, no. 554, pp. 362–363, illus. August 24, 1939. (Published by the British Broadcasting Corp.)

FOOKS, H. A. Effects of mauling by tiger. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 169–170. 1939.

FORMOZOV, A. On competition between species. Mutual relations between the squirrel (*Sciurus vulgaris* L.), the crossbill (*Loxia curvirostra* L.), and the great spotted woodpecker (*Dryobates major* L.). Comptes Rendus Acad. Sci. URSS, Leningrad, vol. 3, no. 3, pp. 197–201. July 21, 1934. (In Russian, with English summary.)

——— Wanderungen des gemeinen Eichhörnchens. Trav. Inst. Zool. Acad. Sci. URSS, Moscou, vol. 3, pp. 97–164, figs. 13, tables 3. 1936. ("Migrations of the common squirrel (*Sciurus vulgaris*) in USSR." In Russian.)

FORMOZOV, A. N., and A. G. VORONOV. Principal features of the activity of rodents on pastures and meadow land. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 3 (8), no. 8 (68), pp. 370–372. 1935.

FOSTER, MARK A., R. C. FOSTER and R. K. MEYER. Hibernation and the endocrines. Endocrinology, Los Angeles, vol. 24, no. 5, pp. 603–612. May, 1939.

FRECHKOP, SERGE. Notes sur les mammifères. XXIV. Remarque concernant le *Myotis welwitschi* (Gray). Bull. Mus. roy. Hist. nat. Belgique, Bruxelles, vol. 15, no. 29, pp. 3. May, 1939.

FRIANT, M. Persistance d'un caractère archaïque fondamental des molaires supérieures chez le Hérisson actuel. Sci. Nat., Paris, vol. 1, no. 5, pp. 134–140. 1939.

FRY, DONALD H., JR. A winter influx of sea lions from Lower California. California Fish and Game, San Francisco, vol. 25, no. 3, pp. 245–250, figs. 93–95, table. July, 1939.

FUGATE, ROY. Swift fox den found. Murrelet, Seattle, vol. 20, no. 2, May–August, p. 44. August 10, 1939. (Oregon.)

GILLESPIE, T. H. The national zoological park of Scotland. Zoologische Garten, Leipzig, n. F., vol. 10, nos. 3–4, pp. 141–147, illus. 1938.

GABRIELSON, IRA N. Range restoration. Bird-Lore, New York, vol. 41, no. 2, pp. 63–66. March–April, 1939. (Charles Sheldon and Hart Mountain Refuges. Antelope.)

GEE, E. P. Strange behaviour of a tigress. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 614. September 25, 1937.

GERSTELL, RICHARD. A progress report on Pennsylvania's new rabbit program. Pennsylvania Game News, New Cumberland, vol. 10, no. 3, pp. 4–5, 31. June, 1939.

GOETHE, FRIEDRICH, and ELIZABETH GOETHE. Aus dem Jugendleben des Muffelwildes. Zoologische Garten, Leipzig, n. F., vol. 11, nos. 1–2, pp. 1–22, illus. June, 1939.

GOLDING, F. D. Nigerian pets. V.—"Whiskers" the palm squirrel. Nigerian Field, London, vol. 7, no. 3, pp. 121–123, illus. July, 1938.

GOODRUM, PHIL. Notes on the gray and fox squirrels of eastern Texas. Trans. Second North Amer. Wildlife Conference, Washington, D. C., pp. 499–504. March, 1937.

GOODWIN, GEORGE G. A new bandicoot from Iran. Amer. Mus. Novitates, New York, no. 1048, p. 1. November 22, 1939. (New: *Nesokia legendrei*.)

——— Five new rodents from the eastern Elburz Mountains and a new race of hare from Teheran. Amer. Mus. Novitates, New York. no. 1050, pp. 5. December 1, 1939. (New: *Glis glis petruccii, Calomyscus elburzensis, Meriones* (*Parameriones*) *persicus gurganensis, Meriones* (*Pallasiomys*) *iranensis, Rhombomys opimus sodalis, Lepus europaeus iranensis*.)

GORHAM, FRANK W., and ANDREW CONWAY IVY. General function of the gall bladder from the evolutionary standpoint. Field Mus. Nat. Hist., Chicago, zool. ser., vol. 22, no. 3, pp. 159–213. June 21, 1938.

GRATER, RUSSELL K. The Black Canyon of the Gunnison River. Nature Notes. Peoria, Ill., vol. 6, no. 6, pp. 124–128. June, 1939.

GRAFFLIN, ALLAN L., and JOHN J. FOOTE. Epithelial cell shapes in the first segment of the proximal tubule of the cat nephron, as demonstrated by chromesome-silver method. Amer. Jour. Anat., Philadelphia, vol. 65, no. 2, pp. 179–198, 3 pls. September 15, 1939.

GRAY, R. W. The walrus. Naturalist, London, no. 991, pp. 201–207. August, 1939.

——— Harpoons and the capture of whales. Naturalist, London, no. 992 (no. 765 current ser.), pp. 245–249. September, 1939. (Methods and procedures followed in the harpooning of the Greenland, bottlenose, sperm and southern right whales.)

GREEN, EARL L. The inheritance of a rib variation in the rabbit. Anat. Record, Philadelphia, vol. 74, no. 1, pp. 47–60. May 25, 1939.

GREFFENIUS, R. J. A method for determining the relative abundance of *Microtus pennsylvanicus*. Jour. Wildlife Management, Menasha, vol. 3, no. 3, pp. 199–200. July, 1939.

GREGORY, WILLIAM K., and MILO HELLMAN. The dentition of the extinct South African man-ape *Australopithecus* (*Plesianthropus*) *transvaalensis* Broom. A comparative and phylogenetic study. Annals Transvaal Mus., Cambridge, England, vol. 19, pt. 4, pp. 339–373, figs. 14, tables 8. June 6, 1939.

——— On the evolution and major classification of the civets (*Viverridae*) and allied fossil and recent carnivora: A phylogenetic study of the skull and dentition. Proc. Amer. Philos. Soc., Philadelphia, vol. 81, no. 3, pp. 309–392, figs. 33, tables 11. August 31, 1939.

GRIFFIN, DONALD R. Wings without feathers. New England Naturalist, Boston, no. 4, pp. 11–13, illus. September, 1939. (Flying reptiles and mammals.)

GUILLAUME, LOUIS. *Elephas primegenius* [sic] Blum. aux environs de Montmédy (Meuse). Bull. Mensuel Soc. Sci., Nancy, n. s., vol. 4, nos. 3–4, pp. 76–79, illus. April–May, 1939.

GUREEV, A. Kraniologische Merkmale der Wald- und Steppenhasen. Trav. Inst. Zool. Acad. Sci. URSS, Moscou, vol. 3, pp. 353–366, figs. 8, tables 6. 1936. (Craniological characters of *Lepus europaeus* Pall. and *L. timidus* L. In Russian, with English summary.)

HALE, HERBERT M. Rare whales in South Australia. South Australian Naturalist, Adelaide, vol. 19, no. 4, pp. 5–8, figs. 3. June 1, 1939. (*Berardius arnouxii*, *Mesoplodon layardii*, *Hyperoödon planifrons*, *Kogia breviceps*.)

HALL, E. RAYMOND. The grizzly bear of California. California Fish and Game, San Francisco, vol. 25, no. 3, pp. 237–244, figs. 90–92. July, 1939.

——— and WALTER W. DALQUEST. On the characters of the pocket gopher *Thomomys talpoides couchi* Goldman. Murrelet, Seattle, vol. 20, pp. 38–39. August, 1939.

HAMILTON, J. E. A second report on the southern sea lion, *Otaria byronia* (de Blainville). Discovery Reports, Cambridge, vol. 19, pp. 121–164, figs. 6, tables 14, pls. 26–33. 1939.

HAMILTON, W. J., JR., and RUSSELL P. HUNTER. Fall and winter food habits of Vermont bobcats. Jour. Wildlife Management, Menasha, vol. 3, no. 2, pp. 99–103, table 1. April, 1939.

HAMMOND, WARNER SMITH. On the origin of the cells lining the liver sinusoids in the cat and the rat. Amer. Jour. Anat., Philadelphia, vol. 65, no. 2, pp. 199–227, 5 pls. September 15, 1939.

HAMPE, IRVING E. Notes on the mammals of the Patapsco State Park. Bull. Nat. Hist. Soc. Maryland, Baltimore, vol. 10, no. 1, pp. 4–7. September, 1939.

HARPER, FRANCIS. The name of the Blesbok. Proc. Biol. Soc. Washington, vol. 52, pp. 89–91. June 5, 1939. (*Damaliscus phillipsi* Harper, p. 90.)

HARRIS, H. A. Growth of the mandible in the pig. Nature, London, vol. 144, no. 3647, pp. 552–553, figs. 2. September 23, 1939.

HASWELL, F. W. Curious behaviour of elephants. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, p. 560. December, 1938.

HEINTZ, ANATOL. Forhistoriske menneskefunn. 3. Neandertal-mannen fra Europa. Naturen, København, Årgang 63, nos. 7–8, pp. 215–229, figs. 25–29. July–August, 1939.

HELM, O. L. Preliminary report on fossil whale mandible. Bull. Nat. Hist. Soc. Maryland, Baltimore, vol. 9, no. 12, pp. 107–110, figs. 3. August, 1939. (Two mandibles found at Governor's Run, Calvert Cliffs, Maryland, in 1932.)

HELM, O. Delfinen, Springeren (*Delphinus delphis* L.) i de danske Farvande. Naturens Verden, Bergen, vol. 23, no. 9, pp. 385–391, illus. 1939. (Photographs of swimming porpoises.)

HENSHAW, PAUL C. A Tertiary mammalian fauna from the Avawatz Mountains, San Bernardino County, California. Carnegie Inst. Washington, publ. no. 514, pp. 1–30, figs. 3, pls. 6. May 18, 1939.

HEPTNER, W. G., and A. W. SAMORODOW. Une nouvelle sous-espèce de gerboise *Alactagulus acontion* Licht. de Turkestan. Mammalia, Paris, vol. 3, nos. 3–4, pp. 109–110. December, 1939. (New: *Alactagulus acontion turcomanus*.)

HESLOP, I. R. P. Names of mammals in three Nigerian languages. Jour. Soc. Preservation Fauna of Empire, Hertford, n. s., pt. 34, pp. 88–90. August, 1938.

HIBBARD, CLAUDE W. Notes on additional fauna of Edson Quarry of the Middle Pliocene of Kansas. Trans. Kansas Acad. Sci., Topeka, vol. 42, pp. 457–462, figs. 6. 1939. (New: *Perognathus dunklei*, *Prodipodomys* for *Dipodomys kansensis* Hibbard, *Oryzomys ? pliocaenicus*.)

———— Notes on some mammals from the Pleistocene of Kansas. Trans. Kansas Acad. Science, Topeka, vol. 42, pp. 463–479, pls. 1–5, tables. 1939.

HIESTAND, WM. A., and WALTER C. RANDALL. An apparatus for raising the body temperature of small animals. Amer. Midland Nat., Notre Dame, vol. 22, no. 1, pp. 214–215. July, 1939.

HILL, W. C. OSMAN. The menstrual cycle of the toque macaque (*Macaca sinica* Linn.), with observations on its uterine structure, compared with that of other macaques. Ceylon Jour. Sci., Colombo, sect. D., Med. Sci., vol. 5, pt. 2, pp. 21–36, figs. 2, pls. 3. September 4, 1939.

———— and P. K. CHANMUGAM. The lobule of Wrisberg on the right lung. Ceylon Jour. Sci., Colombo, sect. D, Med. Sci., vol. 5, pt. 2, pp. 47–52, fig. 1, pl. 8. September 4, 1939.

———— Additional note on the lobule of Wrisberg in the cetacean right lung. Ceylon Jour. Sci., Colombo, sect. D, Med. Sci., vol. 5, pt. 2, pp. 53–54, fig. 1. September 4, 1939.

HILZHEIMER, MAX. *Bison iselini* Stehlin für *Bubalus iselini* Stehlin. Zeitschr. f. Säugetierkunde, Berlin, vol. 13, pp. 254–256. September 1, 1939.

———— Die Tierknochen von Rerik. Zeitschr. f. Säugetierkunde, Berlin, vol. 13, pp. 164–171, pl. 29. September 1, 1939.

HOARE, W. B. Sanctuary. The Beaver, Winnipeg, Outfit 270, no. 1, pp. 38–41, illus. June, 1939. (Musk-oxen in Thelon Game Sanctuary.)

HOLT, ERNEST G. Birds and beasts aid erosion control. Conservation, Amer. Forestry Assoc., Washington, D. C., vol. 5, no. 3, pp. 23–26. May–June, 1939.

HUBBACK, THEODORE. Wild life photography in the Malayan jungle. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 48–63, 8 pls. 1939.

———— (Review). Annual report on game preservation in Burma for the year ended 31st March 1938. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 161–163. 1939.

HUBBACK, T. R. Behaviour of sambhur in the presence of wild dogs. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 172. 1939.

HUBBARD, WYNANT DAVIS. Netting game in Northern Rhodesia. The exciting capture alive of thirteen oribi, three reedbuck, and a fine, fat zebra mare. The Sportsman, Boston, vol. 7, no. 6, ppl. 72, 73, 92, 94, illus. June, 1930.

HUBBS, CARL L. Killing the term, predatee. Science, Lancaster, n. s., vol. 89, no. 2322, p. 605. June 30, 1939.

HUBER, W. W. The ghost of buck bones. American Wildlife, Washington, D. C., vol. 28, no. 4, pp. 188–191, figs. 3. July–August, 1939. (White-tailed deer on Pisgah National Forest, North Carolina.)

IBBOTSON, J. A baby elephant. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, pp. 558–559, 1 pl. December, 1938.

IZIRI, SYOZI. Histological study of the teeth of *Desmostylus*. Jour. Geol. Soc. Japan, Tokyo, vol. 46, no. 548, pp. 220–230, figs. 13, 1 table. May 20, 1939. (*Desmostylus japonicus*. In Japanese, with German résumé.)

JACKSON, J. WILFRID. Discovery of remains of the Celtic short-horned ox, *Bos longifrons* Owen, at Whitepark Bay, Co. Antrim. Irish Naturalist's Jour., Belfast, vol. 7, no. 6, pp. 189–193, illus. June, 1939.

JACKSON, T. H. E. A bat nursery. Jour. East Africa and Uganda Nat. Hist. Soc., London, vol. 14, no. 3 (64), p. 180. June, 1939. (*Miniopterus natalensis arenarius*.)

JOHNSON, GEORGE B. Surry County's big buck. Virginia Wildlife, Blacksburg, vol. 1, no. 11, pp. 2–3. July, 1938.

JOHNSON, HARLEN G. Game management. Arizona Wildlife and Sportsman, Phoenix, vol. 1, no. 8, pp. 5, 9. August, 1939.

JOHNSTON, C. STUART. A skull of *Osteoborus validus* from the early middle Pliocene of Texas. Jour. Paleont., Chicago, vol. 13, no. 5, pp. 526–530, figs. 8. September, 1939.

KALABUCHOW, N. On the causes of fluctuations in numbers of the mouselike rodents. Zool. Zhurnal, Moscou, vol. 14, no. 2, pp. 209–242, figs. 6, tables 20. 1935.

———— Results of investigations on the ecology of harmful rodents in the USSR for twenty years. Zool. Zhurnal, Moscou, vol. 16, no. 5, pp. 950–967, figs. 10, tables 4. 1937. (In Russian.)

KALABUKHOV, N. I. Fundamental laws of the dynamics in mammalian and bird-populations. Uspekhi Sovremennoi Biologii, Moscou (Advances in Modern Biology), vol. 7, no. 3, pp. 505–531, figs. 10, tables 2. 1937. (In Russian.)

KASHKAROV, D. N. The ecology of domestic animals on the example of the Karakul sheep. Priroda, Leningrad, no. 9, pp. 47–67, figs. 18. 1937. (In Russian.)

KAZANTZEWA, J. M., and B. K. FENIUK. Zur Oekologie des Erdhasen *Dipus sagitta* Pall. (Mammalia). Uchenye zapiski Saratovskogo gosudarstvennogo universiteta imeni N. G. Chernyshevskogo (Abhandl. Tschernyschewsky-Staatsuniversität Saratow), Saratov, vol. 1, biol. ser., no. 14, pp. 134–166, figs. 27. 1937. (In Russian, with German summary.)

KEEFE, E. J. The American beaver saves the land and water. Frontiers, Philadelphia, vol. 3, no. 5, pp. 154–155, 2 photos. June, 1939.

KELSO, LEON H. Food habits of prairie dogs. U. S. Dept. Agric., circ. no. 529, pp. 15. June, 1939.

KELWAY, PHYLLIS. Yellow-necked mouse. Game and Gun and Angler's Monthly, London, vol. 16, no. 165, pp. 352–354, illus. June, 1939. (*Apodemus flavicollis wintoni.*)

——— The mole. Game and Gun and Angler's Monthly, London, vol. 16, no. 166, pp. 419–421, illus. July, 1939. (*Talpa europaea.*)

——— The harvest mouse. Game and Gun and Angler's Monthly, London, vol. 16, no. 167, pp. 488–491, illus. August, 1939. (*Micromys minutus.*)

KING, HELEN DEAN. Labyrinthitis in the rat and a method for its control. Anat. Record, Philadelphia, vol. 74, pp. 215–222. June 25, 1939.

KINGSBURY, B. F. The question of a lateral thyroid in mammals with special reference to man. Amer. Jour. Anat., Philadelphia, vol. 65, no. 2, pp. 333–359, 3 pls. September 15, 1939.

KIRIKOFF, S. W. Sur la distribution géographique discontinuée des *Evotomys glareolus* Schreb. Bull. Soc. Nat. Moscou, sect. biol., n. s., vol. 44, no. 5, pp. 250–252. 1935. (In Russian, with French résumé.)

KLEIN, BRUNO M. Beobachtungen an einer jungen Siamkatze über Vergessen und Erinnern in Bezug auf die Umgebung. Zoologische Garten, Leipzig, n. F., vol. 11, nos. 1–2, pp. 24–31. June, 1939.

KNOWLES, RUTH KALES. Happy hunting grounds for coyote in a Yosemite meadow. Yosemite Nat. Notes, Stockton, vol. 18, no. 7, pp. 84–85. July, 1939.

KORVENKONTIO, V. A. Mikroskopische Untersuchungen an Nagerincisiven unter Hinweis auf die Schmelzstruktur der Backenzähne. Histologisch-phyletische Studie. Annales Zool. Soc. Zool.-Bot. Fenn. Vanamo, Helsinki, vol. 2, no. 1, pp. I–XIV, 1–280, text figs. 3, pls. 1–47. 1934–1935.

KROGMAN, WILTON MARION. Contributions of T. Wingate Todd to anatomy and physical anthropology. Amer. Jour. Phys. Anthrop., Philadelphia, vol. 25, no. 2, pp. 145–186. July–September, 1939.

KUZNETZOFF, B. A. On a certain regularity in the distribution of mammals over the European part of the USSR. Zool. Zhurnal, Moscou, vol. 16, no. 1, pp. 165–182, tables. 1937. (In Russian, with English summary.)

——— Uber einige Gesetzmässigkeiten der Säugetierverbreitung im europäischen Teil des UdSSR. Zool. Zhurnal, Moscou, vol. 15, no. 1, pp. 96–127, 7 maps. 1936. (In Russian.)

LAMBERT, HENRY. White woodchucks. Nature Mag., Washington, D. C., vol. 32, no. 3, p. 134. March, 1939.

LAMBERTON, C. Une dernière prémolaire anormale (P^4.) chez *Megaladapis grandidieri*. Mammalia, Paris, vol. 3, no. 2, pp. 53–54, figs. 2, pl. 4. June, 1939.

LAPTEV, M. K. To the methods of a quantitative account (the bioaccount) of the rodents as the injurers to agriculture. Trudy Turkmenskii sel'skokhoziaistvennyi institut (Arbeiten d. Turkmenischen Landwirtschaftlichen Hochschule), Baku, vol. 1, pp. 109–149. 1935.

LARINA, N. J. Notes on the ecology of small Dipodidae (Mammalia) of the Kalmuck Steppes. Abhandl. Tschernyschewsky-Staatsuniversität Saratov, vol. 1 (XIV) biol. ser., no. 2, pp. 101–120, figs. 9, tables 3. 1939.

LAURENT, P. Présence de l'oreillard d'Europe (Plecotus auritus auritus L.) dans le sud Tunisien. Bull. Mus. Hist. Nat., Paris, ser. 2, vol. 11, no. 3, pp. 279–282. 1939.

——— A propos de la présence de l'oreillard d'Europe, *Plecotus auritus auritus* L., au Japon. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 11, no. 4, pp. 356–359, table. May, 1939.

——— Détermination du poids du macroscelide adulte. Mammalia, Paris, vol. 3, no. 2, pp. 55–56, fig. 1. June, 1939.

LAWROFF, N. P. Sur la biologie du putois ordinaire (*Putorius putorius* L.). Bull. Soc. Nat. Moscou, sect. biol., n. s., vol. 44, nos. 7-8, pp. 362-373, tables 10. 1935. (In Russian, with French résumé.)

LEOPOLD, A., E. B. MOORE, and L. K. SOWLS. Wildlife food patches in southern Wisconsin. Jour. Wildlife Management, Menasha, vol. 3, no. 1, pp. 60-69. 1939.

LEWIS, G. EDWARD. A new Bramatherium skull. Amer. Jour. Science, New Haven, vol. 237, no. 4, pp. 275-280, pl. 2. April, 1939. (*B. megacephalum.*)

——— Siwalik fossil *Mastomys*. Amer. Jour. Sci., New Haven, vol. 237, pp. 341-344, pl. 1. May, 1939. (New: *Mastomys colberti.*)

LEWIS, JOHN B. Naturalist writes of Dismal Swamp. Virginia Wildlife, Blacksburg, vol. 2, no. 7, p. 2. March, 1939. (Bear, deer, wildcat, opossum, raccoon, mink, rabbit, and otter.)

LICHE, H., and KAZIMIERZ WODZICKI. Vaginal smears and the oestrous cycle of the cat and lioness. Nature, London, vol. 144, no. 3640, pp. 245-246. August 5, 1939.

LIEBUS, ADALBERT. Über neue Anthracotheriiden- und Suidenreste aus dem böhmischen Tertiär. Lotos, Prag, vol. 86, pp. 63-69, pl. 1. 1938.

LINNAEUS, C. Regnum Animale, Tenth edition (1758) vol. 1, photographic facsimile, London, Brit. Mus. (Nat. Hist.), 1939. (See Calman, Nature, London, vol. 144, no. 3641, p. 269. August 12, 1939.)

LISTER, F. H. Occurrence of tiger in northern Sikkim. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, p. 553. December, 1938.

LITTLE, C. C. Some contributions of the laboratory rodents to our understanding of human biology. Amer. Nat., Lancaster, vol. 73, no. 745, pp. 127-138. March-April, 1939.

LONG, J. A. A pulsating circulation apparatus for tissue cultures, embryos, and small organs. Univ. Calif. Publ. Zool., Berkeley, vol. 43, no. 10, pp. 211-216, 1 pl. 1939.

LONG, WILLIAM H. Apparatus for measuring metabolism and activity in wild animals. Univ. Michigan, School Forestry and Conserv., Ann Arbor, Circ. no. 5, pp. 1-35. 1939.

LÖNNBERG, EINAR. Notes on marmosets. Arkiv för Zool., Stockholm, vol. 32A, no. 10, pp. 1-22. 1940. (New: *Mystax imperator subgrisescens, M. imberbis, Cebuella pygmaea niveiventris.*)

LOWTHER, FLORENCE DEL. Maholi galagos breed in captivity. Science, Lancaster, n. s., vol. 89, no. 2322, p. 604. June 30, 1939.

LUGN, A. L. Notes on the Valentine question. Amer. Jour. Sci., New Haven, vol. 237, no. 6, pp. 433-438. June, 1939.

LUKASIAK, JAKUB. Badania nad fauna helmintologiczna Polski (Recherches sur la fauna helminthologique en Pologne). Fragm. Faun. Mus. Zool. Pol., Warsaw, vol. 4, no. 5, pp. 93-106. June 10, 1939.

LUTTRINGER, LEO A., JR. Dramas of the wild. Pennsylvania Game News, New Cumberland, vol. 10, no. 5, pp. 12-15, illus. August, 1939.

LYON, MARCUS WARD, JR. The least weasel in St. Joseph County [Indiana]. Amer. Midland Nat., Notre Dame, vol. 22, no. 1, p. 216. July, 1939.

——— (Review of) Bats, by Glover Morrill Allen. Amer. Midland Nat., Notre Dame, vol. 22, no. 2, pp. 478-479. September, 1939.

MADSEN, HOLGER. Does the rabbit chew the cud? Nature, London, vol. 143, no. 3632, pp. 981-982. June 10, 1939. (Coprophagy, mistaken for cud chewing, is a normal and regular physiological process.)

MAES, J. P. Neural mechanism of sexual behavior in the female cat. Nature, London, vol. 144, no. 3648, pp. 598-599. September 30, 1939.

MAHAN, S. A. El Octodon cummingii como animal de laboratorio. Rev. Chilena Hist. Nat. pura y aplicada, Santiago, vol. 41, pp. 43–45, fig. 4. 1937.

MAGNE DE LA CROIX, P. De l'origine des pinnipedes. Ann. Soc. Cientif. Argentina, Buenos Aires, vol. 123, no. 6, pp. 321–328, figs. 6. June, 1937.

MALLET-VEALE, A. J. Horned royalty of South Africa. Nature Mag., Washington, D. C., vol. 32, no. 3, pp. 132–134. March, 1939.

MANDACH, E. V. Skelettreste von *Dicrostonyx groenlandicus* Traill als Inhalt von Raubvogelgewöllen. Untersuchung von Raubvogelgewöllen, gesammelt von Mitgliedern der daenischen Dreijahres-Expedition nach Nordostgrönland 1931–34. Meddelelser om Grønland, Kommissionen for Videnskabelige Undersogelser i Grønland, København, vol. 112, no. 4, pp. 54, figs. 2, pls. 1–22. 1938.

MARSHALL, CLYDE, and RALPH G. MEADER. Studies on the electrical potentials of living organisms: I. Base-lines and strain differences in mice. Yale Jour. Biol. and Medicine, New Haven, vol. 10, no. 1, pp. 65–78. October, 1937.

MARSHALL, G. H. L. Measurements of tigers in the Naga Hills, Assam. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 615. September 25, 1937.

MATSUMOTO, HIKOSHICHIRÔ. Résumé on Hemimastodon, a little-known genus of fossil Proboscidea. Vol. Jubilare for Prof. Sadao Yoshida, Osaka, pp. 1301–1317, figs. 8. March, 1939.

———— On two species of fossil mammals from Kazusa. Zool. Mag., Tokyo, vol. 51, no. 5, pp. 257–266, figs. 2. May, 1939. (New: *Zalophus kimitsensis*.)

MATTHES, ERNST. Algúmas observações sôbre a língua dos Pinipédios. Rev. Faculdade Ciências, Univ. Coimbra, vol. 7, no. 1, pp. 40–45. 1938.

MATTHEWS, L. HARRISON. The bionomics of the spotted hyaena *Crocuta crocuta* Erxl. Proc. Zool. Soc. London, vol. 109, ser. A, pt. 1, pp. 43–56, 4 pls. May, 1939.

———— The subspecies and variation of the spotted hyaena, *Crocuta crocuta* Erxl. Proc. Zool. Soc. London, vol. 109, ser. B, Syst. and Morphol., pt. 2, pp. 237–260, figs. 20, tables 2. August 2, 1939.

MCCANN, C. Notes on Hardwicke's hedgehog (*Hemiechinus collaris* Gray and Hardw.). Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 616. September 25, 1937.

———— Number of young hedgehogs have at a birth. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, p. 171. 1939. (Not more than four.)

MCCUTCHEN, A. A. Rare mammals. Wyoming Wild Life, Cheyenne, vol. 4, no. 7, p. 7. July, 1939.

MCDOUGALL, D. S. A. A white giraffe. Field, London, vol. 174, no. 4534, p. 1003. November 18, 1939.

MCGREW, PAUL O. Nanodelphys, an Oligocene didelphine. Field Mus. Nat. Hist., Chicago, geol. ser., vol. 6, no. 26, pp. 393–400. October 31, 1939.

MEKLENBURTZEW, R. N. Zur Ökologie und Verbreitung einiger Nagetiere im Ebene-Teil des Zerawschantales. Acta Univ. Asiae Med., Taschkent, ser. 8a, Zool., no. 17, pp. 3–30, figs. 5, 1 table. 1935. (In Russian, with German summary.)

MERRIAM, JOHN CAMPBELL. Published papers and addresses. Carnegie Inst. Washington, D. C., Publ. no. 500, vol. 1, pp. viii + 1–666, illus; vol. 2, pp. vi + 669–1288, illus.; vol. 3, pp. viii + 1291–1944, illus.; vol. 4, pp. vii + 1947–2672, illus. 1938.

MERTENS, ROBERT. Zoologische Eindrücke von einer Kamerun-Reise. Natur und Volk, Frankfurt a. M., vol. 68, no. 12, pp. 594–597. December 1, 1938. (*Hypsignathus monstrosus*.)

MEYER, K. F. The role of the infected and the infective flea in the spread of sylvatic

plague. Vierteljahrsschrift Naturf. Gesell. Zürich, vol. 83, no. 30, pp. 160–169. 1938.

MILLAR, G. D. L. Weight of tusks of the Indian elephant. Jour. Bombay Nat. Hist. Soc., vol. 41, no. 1, pp. 171–172. 1939.

MOHR, OTTO L., and PER TUFF. The Norwegian platinum fox. A coat color mutation having great economic value. Jour. Heredity, Washington, D. C., vol. 30, no. 6, pp. 227–234. June, 1939.

MONNIG, H. O. *Ancylostoma hescheleri* n. sp. from the antbear, *Orycteropus afer*, with a note on a new variety *A. caninum*. Vierteljahrsschrift Naturf. Gesell. Zürich, vol. 83, no. 30, Festschrift Karl Hescheler, pp. 1–5. November 3, 1938.

MOONEY, MARK, JR. Photography at the Zoo. The Camera, Philadelphia, vol. 58, no. 6, pp. 399–404. June, 1939.

MOORMAN, R. F. Notes on the fossil vertebrates of the Hamstead beds. Proc. Isle of Wight Nat. Hist. and Archaeol. Soc., Newport, vol. 3, pt. 1, pp. 81–85. August 10, 1939.

MORRIS, RANDOLPH C. Encounters with a rogue elephant. Indian Wild Life, Agra, vol. 4, no. 2, pp. 65–68. April–June, 1939.

MORRIS, R. C. Solitary bull bison (*Bibos gaurus* H. Sm.). Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 617. September 25, 1937.

——— Colouration of the bison's snout and tongue. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 618. September 25, 1937.

——— Close seasons for big game—are they beneficial? Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, pp. 621–622. September 25, 1937.

——— Measurements of tiger, panther, bison, and sambhur. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, p. 555. December, 1938.

——— 'Stamping grounds' and 'sore neck' in Sambar. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, pp. 560–561. December, 1938.

MOTTL, MÁRIA. Zwei neue Pleistozäne Säugetierskelette im Museum der Kgl. Ung. Geol. Anstalt. Földtani Közlony (Geol. Mitteil.), Budapest, vol. 68, nos. 4–6, pp. 103–109, figs. 6. 1938.

NAUMOV, N. P. Die Säugetiere des Tungusska-Bezirks. Akad. nauk, Poliarnaia komissiia (Rept. Polar Commission Acad. Sci. USSR), Leningrad, vol. 17, pp. 5–82, map, tables 10. 1934. (New: *Sorex macropygmaeus* natio *tungusensis, S. ussuriensis tschekanovskii; Ochotona (Pika) hyperborea turuchanensis; Evotomys rutilus vinogradovi*. In Russian, with German summary.)

NEAVE, SHEFFIELD A. Nomenclator Zoologicus. A list of the names of genera and subgenera in zoology from the Tenth edition of Linnaeus 1758 to the end of 1935., vol. 1 (A–C). Zool. Soc. London, pp. xiv + 958. 1939.

NECKER, WALTER L. Check list of mammals of the Chicago region. Chicago Acad. Sci. Leaflet No. 9, 4 pp. (not paged). July 21, 1939.

NELSON, E. W. Mountain sheep of North America. The Sportsman, Concord, New Hampshire, vol. 13, no. 3, pp. 31–33, illus., table. March, 1933.

NEUVILLE, H. Étude sur l'évolution des epithéliums et remarques sur l'état precancereux à propos d'un papillome vulvo-vestibulaire d'éléphant. Archiv. d'Anatomie, d'Histologie et d'Embryologie, Strasbourg, vol. 27, pp. 1–84, 14 figs., 6 pls. 1939.

OREKYER, R. O. [Bushcow]. Nigerian Field, London, vol. 8, no. 3, pp. 130–131. July, 1939.

ORLOV, E. J., and H. K. LONSINGER. Zur Methodik quantitativer Untersuchungen der Waldmicromammalia. Uchenye zapiski Saratovskogo gosudarstven-

nogo universiteta imeni N. G. Chernyshevskogo, Saratov, vol. 1, biol. ser., pp. 167–175, figs. 2, tables 3. 1937. (In Russian, with German summary.)

Osgood, Wilfred H. The Walters "celluloid" process and its recent applications. Museums Jour., London, vol. 39, no. 4, pp. 180–185, pls. 27–29. July, 1939.

Ouwehand, C. W. Über Geburt und Jugendentwicklung eine Eisbären. Zoologische Garten, Leipzig, n. F., vol. 11, no. 3, pp. 102–107, illus. September, 1939.

Palmer, C. M., Jr. Disease a serious wildlife problem. Virginia Wildlife, Blacksburg, vol. 2, no. 11, pp. 2–3. July, 1939.

———— Animal diseases. Pennsylvania Game News, New Cumberland, vol. 10, no. 6, pp. 14–15, illus. September, 1939.

Palmer, Katherine V. W. Basilosaurus in Arkansas. Bull. Amer. Assoc. Petroleum Geol., Tulsa, vol. 23, no. 8, pp. 1228–1229. August, 1939.

Panfilova, E. P. Difference in blood value of Karakul sheep in correlation with their organic constitution. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 23, no. 6, pp. 569–572, tables 4. 1939.

Paula Couto, Carlos de. Um grande elephante extincto: O mammuth. Rev. Acad. Colombiana Cienc. Exactas, Fis. y Nat. Bogota, vol. 2, no. 7, pp. 458–464, figs. 3. September–October, 1938.

———— Os chiropteros fosseis do Brasil. Rev. Acad. Colombiana Cienc. Exactas, Fis. y Nat. Bogota, vol. 2, no. 7, pp. 464–465, illus. September–October, 1938. (Pleistocene representatives of several recent genera.)

Peters, Nicolaus. Über Grösse, Wachstum und Alter des Blauwales (*Balaenoptera musculus* [L.]) und Finnwales (*Balaenoptera physalus* [L.]). Zool. Anz., Leipzig, vol. 127, nos. 7–8, pp. 193–204, figs. 3. September 1, 1939.

Petrov, B. New vole from South Serbia. Prirodoslovne Razprave, Ljubljana, vol. 3, no. 16, pp. 363–365, illus., table. August 13, 1939. (New: *Sumeriomys guentheri martinoi*.)

Petrov, B. M. New facts concerning the distribution of some mammals in Juogoslavia. Zapiski Russkago Nauchnago Instituta v** Bielgradie, no. 14, Belgrade, pp. 77–83, tables. 1939. (In Russian with English summary.)

Petzsch, Hans. Zucht und Pflege des Wüstenluchses. Zoologische Garten, Leipzig, n. F., vol. 11, nos. 1–2, pp. 23–24, illus. June, 1939.

Pidoplitshka, I. G. Materials for the study of the fossil fauna of the UKR.SSR. Pt. 1. The upper Quaternary fauna of Novgorod-Seversk. Acad. Sci. Ukrainian SSR., Inst. Zool. and Biol., Vidavnistvo Akad. Nauk URSR., Kiev, pp. 3–96, figs. 25, pls. 9, tables. 1938.

———— Materials for the study of the fossil fauna of the UKR.SSR. Pt. 1. A survey of paleontological finds 1917 to 1937. Acad. Sci. Ukrainian SSR., Inst. Zool and Biol., Vidavniststvo Akad. Nauk URSR., Kiev, pp. 97–176, figs. 11, tables. 1938.

———— Contribution to the history of the fauna of the USSR. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 23, no. 6, pp. 609–612. 1939.

Pilgrim, G. E., and S. Schaub. Die schraubenhörnige Antilope des europäischen Oberpliocaens und ihre systematische Stellung. Abhandl. Schweiz. Palaeont. Gesell., Basel, vol. 62, pp. 1–30, figs. 5, pls. 3. 1939. (*Gazellospira torticornis*.)

Pinckney, Philip. Shooting in Sikkim. Jour. Bengal Nat. Hist. Soc., Darjeeling, vol. 14, no. 1, pp. 13–18. June, 1939.

Plyater-Plokhotsky, K. Materials on the study of succession of mouse-like rodents of southern districts of the Far Eastern Region. Vestnik dal'nevostochnogo Filiala Akademii Nauk SSSR, Vladivostok (Bull. Far Eastern Br. Acad.

Sci. USSR), no. 16, pp. 175–177. 1936. (*Microtus, Cricetulus, Apodemus.* In Russian, with English summary.)

PODUVAL, R. V. Whale-bone whale stranded on the Travancore coast. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 3, p. 620. September 25, 1937.

POUGH, RICHARD. Are we over-controlling predators? Conservation, Amer. Forestry Assoc., Washington, D. C., vol. 5, no. 3, pp. 17–19. May-June, 1939.

PRESNALL, C. C. The wildlife program of the National Park Service. Virginia Wildlife, Blacksburg, vol. 1, no. 12, pp. 2–3, 8. August, 1938.

PYCRAFT, W. P. Wild asses. Illus. London News, vol. 192, no. 5172, p. 1019, photos 3. June 4, 1938. (*Equus asinus, E. hemionus, E. kiang, E. onager.*)

——— The "tooth-comb" of the lemurs. Illus. London News, vol. 194, no. 5224, p. 974, figs. 4. June 3, 1939. (Function not yet understood.)

——— Lend me your ears. Illus. London News, vol. 195, no. 5235, p. 297, illus. August 19, 1939. (Photographs showing ears of *Plecotus auritus*, lop-eared rabbit, and eared seal.)

PYTHIAN-ADAMS, E. G. Measurements of tigers shot in the Nilgiris 1925–37. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, p. 553. December, 1938.

——— Measurements of panthers. Jour. Bombay Nat. Hist. Soc., vol. 40, no. 3, p. 554. December, 1938.

RALL, GEORGE M. The relation between rodents and the mosaic landscape of the sandy semi-desert. Zool. Zhurnal, Moscou, vol. 16, no. 1, pp. 149–164, figs. 4, tables 11. 1937. (In Russian, with English summary.)

RALL, G. Indicateur de litérature russe sur le rôle des rongeurs de la Volga basse et du Kazakstan occidentale dans l'épidémiologie de la peste et de la tularémie. Vestnik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidémiol. et Parasitol.), Saratov, vol. 12, no. 3, pp. 229–239. 1934. (In Russian.)

——— Neues über Verbreitung von *Diplomesodon pulchellum* Licht. zwischen den flüssen Wolga und Ural (Mammalia, Insectivora). Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, vol. 3 (8), no. 8 (68), pp. 377–378. 1935.

——— Susliks, *Citellus pygmaeus* Pall. (Mammalia, Glires) in the Volga-Ural Sands. Vestnik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidémiol., et Parasitol.), Saratov, vol. 15, nos. 3–4, pp. 363–379, figs. 3, tables 2. 1936. (In Russian, with English summary.)

——— Thermal conditions in the burrows of rodents living on sandy soils and the method of their investigation. Zool. Zhurnal, Moscou, vol. 18, no. 1, pp. 110–119, figs. 8, tables 2. 1939. (In Russian, with English summary.)

RALL, G., and I. CHUDJAKOW. Verbreitung der Zieseln *Citellus pygmaeus* Pall. in der Sand-steppe der Westlichen Kasakstans. Vestnik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidemiol., et Parasitol.), Saratov, vol. 12, no. 3, pp. 189–198, fig. 1. 1934. (In Russian, with German summary.)

RALL, G., M. DEMIASHEW, and M. SHEIKINA. Periodical phenomena in biology of the most important rodents of sandy semi-desert territories (West Kazakhstan). Vestnik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidemiol., et Parasitol.), Saratov, vol. 15, nos. 3–4, pp. 380–406, figs. 6, tables 15. 1936. (In Russian, with English summary.)

RALL, J. M. Faunistische Forschungen im Wolga-Ural-Sandgelände (Mammalia). Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, vol. 3 (8), no. 7 (67), pp. 329–332, 1 map. 1935.

RASMUSSEN, D. I. Mule deer range and population studies in Utah. 4th North Amer. Wildlife Conference Trans., Washington, D. C., pp. 236–243. 1939.

RAYNAUD, ALBERT, and HENRI HEIM DE BALSAC. Remarques concernant la denture et l'etat d'activité génitale de quelques specimens de *Microtus agrestis* (L). Bull. Soc. Zool. de France, Paris, vol. 64, no. 2, pp. 122–132. 1939.

RCHEULISHVILI, M. D. Variation in tail form in Imeritian sheep. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, n. s., vol. 23, no. 6, pp. 576–579, fig. 1. 1939.

REDFERN, A. W. Camera in place of rifle. Jour. Soc. Preservation Fauna of the Empire, Hertford, n. s., pt. 37, pp. 22–26, pls. 3. August, 1939. (Hippopotamus photographs.)

REEB, A. Baguages de chauves-souris effectués en 1937. Bull. Soc. Hist. Nat. Colmar, (vol. 43), ser. 3 (1937), vol. 1, pp. 139–141. 1939. (*Rhinolophus hipposideros* (Bechstein); *R. ferrum equinum* (Schreber); *Myotis myotis* (Bechstein); *M. bechsteinii* (Leisler).)

RENSHAW, GRAHAM. The thylacine. Jour. Soc. Preservation Fauna of Empire, Hertford, n. s., pt. 35, pp. 47–49, illus. December, 1938. (Tasmania—*Thylacinus cynocephalus*.)

RODE, P. Le baguage des chauves-souris. Sci. Nat., Paris, vol. 1, no. 3, pp. 65–70. March, 1939.

——— Les mammifères de l'Irlande d'après le travail récent de C. B. Moffat. Mammalia, Paris, vol. 3, no. 2, pp. 76–78. June, 1939.

——— (Review of) Pocock, R. I. The fauna of British India, including Ceylon and Burma. Mammalia, vol. 1, Primates and Carnivora (Félidés, Viverridés). Taylor and Francis, London, 1 vol., pp. 463, figs. 106, pls. 31, 1 map. 1939. Mammalia, Paris, vol. 3, no. 2, pp. 81–82. June, 1939.

——— (Review of) Chevasnerie, A. de la. Gibiers et chasses d'Europe. Bibliothèque géographique, Payot, Paris, 1 vol., pp. 271, figs. 11, photos 21. 1939. Mammalia, Paris, vol. 3, no. 2, p. 82. June, 1939.

——— Catalogue des Types de Mammifères du Muséum National d'Histoire Naturelle. Ordre des Primates. B. Sous-ordre des Lémuriens. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 11, no. 5, pp. 434–449. June, 1939.

RODE, P., and P. CANTUEL. Les mammifères de la Collection Mottaz. II. Les chiroptères. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 11, no. 3, pp. 274–278. March, 1939.

ROE, F. G. The numbers of the buffalo. Trans. Roy. Soc. Canada, Ottawa, ser. 3, vol. 31, sec. 2, pp. 171–203. May, 1937.

ROSEVEAR, D. R. The antelopes of Nigeria. V. Neotraginae. Nigerian Field, London, vol. 7, no. 3, pp. 109–111. July, 1938.

ROWLANDS, I. W., and A. S. PARKES. The reproductive processes of certain mammals. 8. Reproduction in foxes (*Vulpes* spp.). Proc. Zool. Soc. London for 1935, pt. 4, pp. 823–841, pls. 6, figs. 2. January 1936. (The male fox is usually monogamous.)

RÜEGER, JAKOB. Zur Osteologie der beiden ersten Halswirbel der Säugetiere. Vierteljahrsshrift Naturforsch. Gessel. Zürich, Jahrg. 83, Beiblatt (Festsch'r. Karl Heschler), pp. 25–56, figs. 10, tables. November 3, 1938.

SCHWARZ, ERNST. A propos du Koula-nguia. Mammalia, Paris, vol. 3, no. 2, pp. 57–58. June, 1939.

SCOTT, WILLIAM BERRYMAN. Some memories of a palaeontologist. Princeton Univ. Press, pp. [7] + 336. 1939.

SHARLEMAN, N. A forgotten mouse species. Priroda, Leningrad, no. 4, pp. 122–123, 1 fig. April, 1937. (*Mus sergii* Valch. In Russian.)

SICKENBERG, O. VON. Die Insektenfresser, Fledermäuse und Nagetiere der Höhlen

von Goyet (Belgien). Bull. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 15, no. 19, pp. 23. April, 1939. (New: *Myotis* (*Leuconoë*) *dasycnemoides*.)

SIEMEL, ALEJANDRE. Hand to claw combat. The thrill of hunting the Brazilian jaguar with a spear. The Sportsman, Concord, N. H., vol. 9, no. 6, pp. 47–48, 86, illus. June, 1931.

STARTSEVA, F. V., and G. A. GLUMOV. Contributions to the ecology and biology of rodents of the Troitsk district, form. Ural province. 4. Influence of farming on the spread of rodents of steppe stations. Izvestiia biologicheskogo Nauchno-Issledovatel'skogo Instituta pri permskom gosudarstevennom Universitete, Perm (Bull. Inst. rech. biol. Perm), vol. 10, no. 3, pp. 125–143, tables 10. 1936. (In Russian, with English summary.)

STOVALL, J. WILLIS. Megalonyx hogani, a new species of ground sloth from Gould, Oklahoma. Amer. Jour. Sci., New Haven, vol. 238, pp. 140–146, figs. 2, pl. 1. February, 1940. (New: *Megalonyx hogani*.)

TATE, G. H. H., and RICHARD ARCHBOLD. Results of the Archbold Expeditions, No. 23. A revision of the genus *Emballonura* (Chiroptera). Amer. Mus. Novitates, New York, no. 1035, pp. 14, figs. 2, tables. July 31, 1939.

TEILHARD DE CHARDIN, P. The post-Villafranchian interval in North China. Bull. Geol. Soc. China, Nanking, vol. 17, no. 1, pp. 169–176, fig. 1. 1937.

TEMPLETON, GEORGE S., FRANK G. ASHBROOK, and CHAS. E. KELLOGG. Rabbit production. U. S. Dept. Agric., Farmers Bull., Washington, D. C., no. 1730, pp. 1–50, figs. 31. June, 1939.

THEMIDO, ANTÓNIO ARMANDO. As Focas do Museu Zoologico de Coimbra. Rev. Faculdade Ciências, Univ. Coimbra, vol. 7, no. 1, pp. 46–51. 1938. (*Phoca vitulina* and *Cystophora cristata*.)

THIENEMANN, AUGUST. Die Ursachen der Stechmücken-Plage im hohen Norden. Natur und Volk, Frankfurt a. M., vol. 68, no. 12, pp. 587–593. December 1, 1938. (Lemming.)

TIFLOW, W., and S. KOLPAKOWA. Die Flöhe des Fuchses (*Vulpes vulpes* L.) und drei neue Floharten aus der U.d.S.S.R. Vestnik Mikrobiol., Epidemiol. i Parazitol. (Rev. Microbiol., Epidemiol., et Parasitol.), Saratov, vol. 15, nos. 3–4, pp. 412–423, figs. 8, tables. 1936.

TOMILIN, A. G. Jumps and the "instinct of pursuit" in the cetacea. Priroda, Leningrad, no. 1, pp. 102–105. January, 1937. (In Russian.)

——— On the explosions of whales. Priroda, Leningrad, no. 1, p. 105. January, 1937. (In Russian.)

TRICOMI, GIUSEPPINA. Cenni su un recente assagio nella grotta di S. Teodoro in Provincia di Messina. Boll. Soc. Sci. Nat. ed Economiche Palermo, n. s., vol. 20, pp. 29–32. 1938. (*Equus hydruntinus*).

TROUGHTON, E. LE G. Queensland rats of economic importance, and new forms of *Rattus* and *Thetomys*. Records Australian Mus., Sydney, vol. 20, no. 4, pp. 278–281. March 31, 1939. (New: *Rattus culmorum apex*, *Thetomys gracilicaudatus ultra*.)

UHRICH, JACOB. The social hierarchy in albino mice. Trans. Kansas Acad. Sci., Topeka, vol. 41, p. 385. 1938.

URBAIN, ACHILLE. Une nouvelle espèce de bovidé asiatique. Comptes rendus Acad. Sci. Paris, vol. 209, pp. 1006–1007. 1939. (New: *Bos* (*Bibos*) *sauveli*.)

VERETSCHAGIN, N. Daghestan mountain goat. Azerbaijan branch of the Academy of Sciences USSR., pp. 1–72, 1938. Pub. by AzFAN, Baku. (In Russian with English summary.)

VERETSCHAGIN, N. Mammals of the Apsheron Peninsula. Azerbaijan branch of the Academy of Science USSR, Pub. by AzFAN, Baku, pp. 1–33. 1938.

——— Daghestan toor (mountain goat) (*Capra cylindricornis* Blyth.) in Azerbaijan. Akad. Nauk SSSR, Azerbaidzhanskii filial, Trudy Zool. Inst., Baku, vol. 9, pt. 45, pp. 72, figs. 31, tables 18. 1938.

VINOGRADOV, B. S. Materials for the study of the dynamics of the fauna of muriform rodents in USSR. (Historical review of fluctuations of mice in USSR). People's Commisariat Agrikulture [sic], Assoc. Pest and Disease Control in USSR Record Service, Leningrad, pp. 63. 1934.

VINOGRADOV, B. S. Short essay on the progress of Soviet therology (mammalogy) for twenty-years. Priroda, Leningrad, no. 10, pp. 180–183. 1937. (In Russian.)

VINOGRADOV, B. S., V. J. GROMOVA, B. A. ZENKEVITSH, M. P. ROZANOV, and S. U. STROGANOV. A brief review on investigations performed on mammals in USSR for 20 years (1917–1937). Bull. Acad. Sci. URSS Cl. Sci. Math. et Nat., Moscou, ser. biol., no. 5, pp. 1503–1513. 1937. (In Russian, with English summary.)

VINOGRADOV, B., and V. SMAL'MAKOVA. Tree climbing jerboas. Priroda, Leningrad, no. 12, pp. 98–100, figs. 3. 1937. (In Russian.) (*Meriones meridianus.*)

WARDLE, ROBERT ARNOLD, MARY JANE GOTSCHALL, and LILLIAN JEAN HORDER. The influence of *Diphyllobothrium latum* infestation upon dogs. Trans. Roy. Soc. Canada, Ottawa, ser. 3, vol. 31, sec. 5, pp. 59–69. May, 1937.

WEILER, W. VON. Vorläufige Mitteilung über eine vierte paläolithische Fundstelle im Pfrimmtal bei Worms. Notizblatt der Hessischen Geologischen Landesanstalt zu Darmstadt, ser. 5, no. 19, pp. 36–39, pl. 3. 1938.

WILLIAM, M. Y. Three skulls of *Bison crassicornis* Richardson from the Yukon. Trans. Roy. Soc. Canada, Ottawa, ser. 3, vol. 31, sec. 4, pp. 105–110, pls. 1–3. May, 1937.

WOOSTER, L. D. An attempt at an ecological evaluation of predators on a mixed prairie area in western Kansas. Trans. Kansas Acad. Sci., Topeka, vol. 41, pp. 387–394, fig. 1, tables 2. 1938.

WÜLKER, KLARA. "Misslungene Versuche der Menschwerdung?" Natur und Volk, Frankfurt a. M., vol. 68, no. 7, pp. 315–317. July, 1938.

YEPES, José. Generalidades y taxonomía de los Mamíferos argentinos. Pt. 1. (Resumen de las conferencias dictadas en octubre de 1934). Rev. Centro Estud. Doctorado Cienc. Nat., Buenos Aires, vol. 1, no. 1, pp. 30–48. May, 1935. (Marsupialia and Chiroptera.)

——— Generalidades y taxonomía de los Mamíferos argentinos. Pt. 2. (Resumen de las conferencias dictadas en octubre de 1934.) Rev. Centro Estud. Doctorado Cienc. Nat., Buenos Aires, vol. 1, no. 2, pp. 98–115. June, 1936. (Carnivora.)

YOUNG, C. C. A new *Stegodon* from Kwangsi. Bull. Geol. Soc. China, Chungking, vol. 18, nos. 3–4, pp. 219–226, pl. 1. December, 1938. (New: *Stegodon preorientalis.*)

ZVEREV, M. D. Materials on the biology and agricultural significance in Siberia of the polecat and other small predators of the family Mustelidae. Trudy po Zashchite Rastenii Sibiri (Bull. Plant Protection Siberia), Novosibirsk, vol. 1, no. 8, pp. 5–46, tables. 1931. (In Russian.)

COMMENT AND NEWS

MEETING OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

The tenth annual convention of the Biological Photographic Association will be held at the Hotel Schroeder, Milwaukee, Wisconsin September 12, 13 and 14. This society is interested in the further study of photography as applied to the biologic sciences, and the improvement of its technic. Scientific photographers from all parts of the country will meet to exchange ideas and information on still and motion picture photography as well as the latest developments in color work. Formal papers will be presented outlining new methods of technic, and there will be informal round-table discussions which will be especially instructive. Commercial firms specializing in the manufacture of scientific photographic apparatus and materials will exhibit and explain the use of their products. A salon consisting of natural color and monochrome prints of biologic and clinical subjects will illustrate a very fine degree of perfection in biologic photography.

ARTHUR H. HOWELL

Arthur H. Howell, a charter member of the American Society of Mammalogists and editor of the Journal of Mammalogy since January, 1938, was stricken with a cerebral hemorrhage in his office in the United States National Museum on the morning of July 9. He died at 3:00 A.M., July 10, 1940, in Emergency Hospital, aged 68 years, 2 months, and 8 days. On July 11, he was buried in Fort Lincoln Cemetery, Washington, D. C.

MEMBERSHIP

Anyone interested in any phase of mammalogy is eligible for membership in the American Society of Mammalogists, and if elected will receive the Society's official publication, the Journal of Mammalogy, quarterly. Name and address, with remittance of $3.00 for annual dues, may be sent to the Corresponding Secretary, or to any officer of the Society. Membership is dated from the nearest January, although formal election will not take place until the annual meeting of the Society following the receipt of application.

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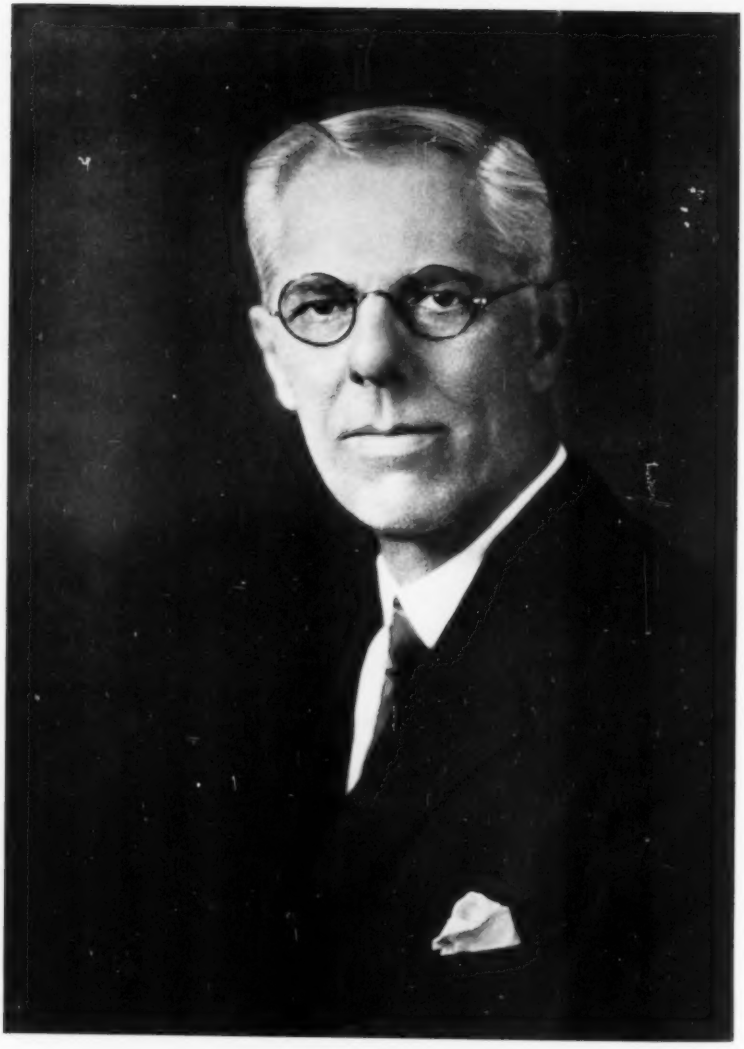

Arthur H. Howell